Hydraulics of Closed Conduit Spillways Part XIII: The Hood Drop Inlet

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Hydraulics of Closed Conduit Spillways
Part XIII:
The Hood Drop Inlet

Study conducted by the

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and the

St. Anthony Falls Hydraulic Laboratory
of the
University of Minnesota

Preface

This publication, the 13th part of a group of publications dealing with the hydraulics of closed conduit spillways, reports tests on the hood drop inlet. The first 11 parts were published as technical papers under the major title "Hydraulics of Closed Conduit Spillways" by the St. Anthony Falls Hydraulic Laboratory (SAFHL), University of Minnesota, Minneapolis, Minn. The 12th part was published under the same major title by the Agricultural Research Service. The following are the earlier publications:

Part I. Theory and Its Application, by F. W. Blaisdell. SAFHL Tech. Paper No. 12, Ser. B, 22 pp., illus., Jan. 1952 (rev. Feb. 1958). Gives theory, symbols, and bibliography.

Parts II through VII. Results of Tests on Several Forms of the Spillway, by F. W. Blaisdell. SAFHL Tech. Paper No. 18, Ser. B, 50 pp., illus., March 1958. Parts II through VI describe the hydraulic performance and present discharge coefficients for five forms of the closed conduit spillway; Part VII discusses vortices and their effect on the spillway capacity.

Part VIII. Miscellaneous Laboratory Tests; Part IX. Field Tests, by F. W. Blaisdell. SAFHL Tech. Paper No. 19, Ser. B, 54 pp., illus., March 1958. Reports tests on models of specific field structures and on field structures themselves.

Part X. The Hood Inlet, by F. W. Blaisdell and C. A. Donnelly. SAFHL Tech. Paper No. 20, Ser. B, 41 pp., illus., April 1958. Reports the development of the hood inlet.

Part XI. Tests Using Air, by F. W. Blaisdell and G. G. Hebaus. SAFHL Tech. Paper No. 44, Ser. B, 53 pp., illus., Jan. 1966. Discusses the use of air for tests of closed conduit spillways.

Part XII. The Two-Way Drop Inlet with a Flat Bottom, by C. A. Donnelly, G. G. Hebaus, and F. W. Blaisdell. ARS-NC-14, 66 pp., illus., September, 1974. Reports tests on the two-way drop inlet for closed conduit spillways and presents recommendations for the spillway design.

The hood drop inlet study was conducted by engineers of the Agricultural Research Service, U.S. Department of Agriculture, Minneapolis, cooperating with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis. Charles A. Donnelly conducted the water experiments. George G. Hebaus and Charles E. Rice designed the hood drop inlet models and initiated the air tests. Kesavarao Yalamanchili completed the air tests and analyzed the data. The study was supervised by Fred W. Blaisdell. This report was written by Yalamanchili and Blaisdell.

Summary

This publication presents results of experiments on hood drop inlet entrances for closed conduit spillways. Spillway performance for various drop inlet heights and sizes is described. Effects of crest wall thickness, barrel wall thickness, barrel slope, drop inlet size, and drop inlet height on the entrance loss and pressure coefficients for square drop inlets with reentrant and flush entrance hoods and circular drop inlets with reentrant hoods are presented. Equations are developed for entrance loss and pressure coefficients and the precision of these equations is discussed. A summary of recommendations presents all the information needed to design hood drop inlet closed conduit spillway entrances.

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Hydraulics of Closed Conduit Spillways
Part XIII:
The Hood Drop Inlet

By Kesavarao Yalamanchili and Fred W. Blaisdell[1]

Introduction

The hood drop inlet for a closed conduit spillway consists of a hood barrel inlet located at the base of a drop inlet. The hood drop inlet (fig. XIII–1) has advantages which, under appropriate circumstances, warrant its use instead of the hood inlet or drop inlet alone.

When a hood drop inlet is used, the drop inlet height and crest length can be selected to give the desired rise in the reservoir level. This is not possible when only the hood inlet is used because the priming head for a 0.75D-long hood is about 1.1D as shown in Part X[2], page 10, and the reservoir level must rise by this amount before the spillway will prime. (The diameter of the barrel is D.) As a result, a hood inlet to a large spillway pipe requires a specific and significant rise in the reservoir level before the spillway achieves its design capacity. The use of a hood drop inlet instead of a hood inlet, where appropriate, will result in a reduction in the height and cost of the dam and/or a preservation of flood storage volume for use to reduce the peak floodwater outflow rate.

The hood inlet also permits a reduction in the drop inlet height. A drop inlet with a square-edged barrel entrance requires a minimum drop inlet height of 5D for satisfactory spillway performance as shown in Parts II through VII, page 32. A hood inlet permits the use of drop inlet heights less than 5D. Thus, the special advantages of the hood inlet and the drop inlet are combined in the hood drop inlet.

During the experiments reported here the performance was determined for square drop inlets with reentrant and flush entrance hoods and circular drop inlets with reentrant hoods. Several hood drop inlet entrances of different forms, heights, and sizes are shown in figure XIII–2. Extensive experimental results are reported that give the entrance energy losses and pressures for various barrel thicknesses and slopes and drop inlet heights and sizes. Equations are presented for the entrance loss and pressure coefficients. A comparison of the entrance energy losses between the square and circular hood drop inlets is reported. The entrance loss and pressure coefficients computed from the equations are compared with the experimental results. The precision of these empirical equations is discussed, and the equations for computing the entrance loss and pressure coefficients are summarized. Examples are given of the application of the equations.

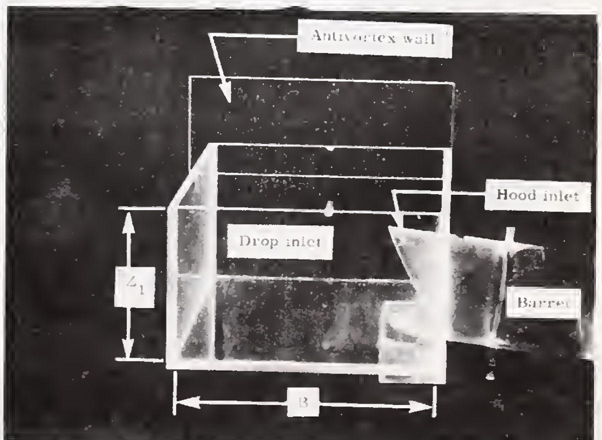

Figure XIII–1.—The hood drop inlet.

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[1] Hydraulic engineers, St. Anthony Falls Hydraulic Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Third Ave. SE. at Mississippi River, Minneapolis, Minn. 55414.

[2] The Roman numerals in references to equations, figures, and parts refer to a particular Part of this series cited in the Preface.

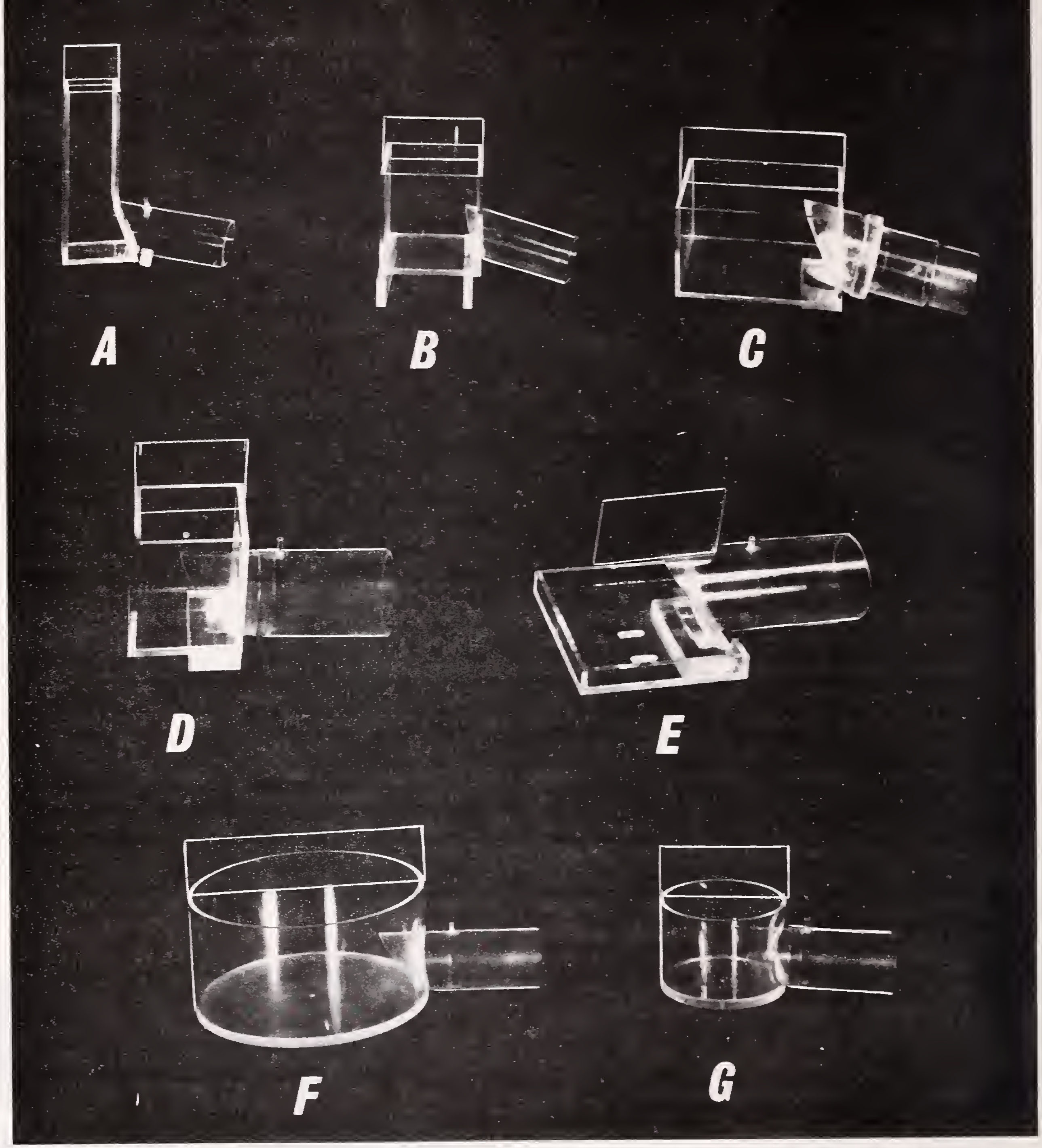


FIGURE XIII-2.—Some of the hood drop inlets tested: **A**, square drop inlet—flush entrance hood; **B**, **C**, **D**, **E**, square drop inlet—reentrant hood, various sizes and heights; **F**, **G**, circular drop inlet—reentrant hood, two sizes.

Experimental Program

Previous experiments on drop inlets and on hood inlet entrances indicated that a combination of the two inlets would have desirable characteristics. However, certain questions required answers to determine if such a combination would perform satisfactorily. Some of the initial questions were: What is the influence of drop inlet size, shape, height, and barrel entrance form—reentrant or flush—on the priming characteristics of the spillway? What are the proportions re-

quired to achieve a unique head-discharge relationship for the hood drop inlet spillway?

Because the full range of flows, which includes weir flow, slug and mixture flow of water and air, and full pipe flow, was explored, the water apparatus, described in Part X, page 3, had to be used to determine the performance characteristics of various spillway configurations—smooth priming of the barrel, formation of harmful vortices, and unique head-discharge relationship. On the other hand, for full pipe flow the determination of entrance coefficients and pressure coefficients was done largely with the air apparatus, described in Part XI, because the coefficients could be obtained easier and more rapidly.

The experimental program included 136 water series and 1087 air series of tests. Each series was comprised of different combinations of the drop inlet form, drop inlet crest wall thickness t_c, drop inlet size B (the length of the side for square drop inlets and the diameter for circular drop inlets), drop inlet height Z_i (measured from the invert of the hood to the drop inlet crest), barrel wall thickness t_p, and barrel slope S (the sine of the angle between the barrel and horizontal). Each series consisted of several test runs, each run representing a different discharge Q through the spillway. The variables are described in the following sections. Table XIII–1 summarizes the experimental program. Experimental program details that are not apparent from a persual of table XIII–1 are explained in the sections that follow.

TABLE XIII–1.—*Summary of experimental program*

Test fluid	Water			Air	
Drop inlet	Square	Circular	Square	Square	Circular
Hood	Reentrant	Reentrant	Flush	Reentrant	Reentrant
Crest thickness, t_c/D	0.111			0.086 0.173 0.215 0.259 0.300 0.402 0.602 1.001 4.007	0.083
Barrel thickness, t_p/D	0.056	0.056	∞	0.001 0.003 0.013 0.024 0.036 0.059 0.099 0.149 0.197	0.001 0.013 0.024 0.036 0.059
Barrel slope, S, percent	20	20	20	0.0 2.5 5.0 10.0 20.0 40.0	0 20
Drop inlet size, B/D	1.00 1.11 1.25 1.50 2.00 4.00 6.00	1.32 1.55 1.98 3.77 5.11	1.00 1.11 1.25 1.50 2.00	1.25 1.50 2.00 2.50 4.00	1.50 2.00 3.83
Drop inlet height, Z_i/D	0.25 0.50 0.75 1.00 1.25 1.50 2.00 4.00	0.25 0.50 0.75 1.00 1.25 1.50 2.00 4.00	0.25 0.50 0.75 1.00 1.25 1.50 2.00 4.00	0.00 0.25 0.50 0.75 1.00 1.25 1.50 3.00 5.00	1.50 2.00 4.00

Discharge

In the water apparatus, where performance was tested, the discharge Q was varied to cover the entire range of weir and partial or full pipe flows. In the air apparatus, where only full pipe flows could be tested, five to seven discharges were used for each series. The pipe Reynolds number $\mathbf{R} = V_pD/\nu = 4Q/\pi D\nu$ ranges covered were from 1.4×10^5 to 2.0×10^5 for the water tests and from 1.2×10^5 to 2.5×10^5 for the air tests. V_p is the barrel velocity and ν is the kinematic viscosity.

Crest wall thickness

To evaluate the effect of crest wall thickness, nine thicknesses t_c, which range from 0.086D to 4.007D, were tested using the air apparatus. The only drop inlet height used was 5D and the barrel slope was zero. Only five barrel wall thicknesses—0.001D, 0.003D, 0.013D, 0.024D, and 0.036D—and two drop inlet sizes—1.25D square and 2.0D square—were used. A crest wall thickness of about 0.08D was used for all other air tests.

Some of these crest thicknesses exceed practical dimensions. The thicker crests actually simulate berms level with the crest.

Barrel wall thickness

Barrel wall thicknesses t_p commonly used in field installations range from about 0.0016D to 0.01D for metal pipes and from 0.1D to 0.2D for concrete pipes. The nine barrel thicknesses ranging from 0.001D to 0.197D used for the air tests cover the above range of thicknesses. Because of practical difficulties in changing the wall thickness in the water apparatus, a barrel 0.056D thick was used for all water tests.

Entrance shapes

Three types of hood drop inlets—the square drop inlet with a reentrant hood, the circular drop inlet with a reentrant hood, and the square drop inlet with a flush entrance hood—were tested. The performance of these entrances was tested using the water apparatus. An extensive test program was conducted with the air apparatus to determine the entrance loss and pressure coefficients for the square drop inlet with a reentrant hood. Sufficient air tests for the circular drop inlet with a reentrant hood were made to determine how the entrance shape affects the entrance loss and pressure coefficients.

Pressure tap locations

Pressures were measured on the barrel invert D/8 and D/2 downstream from the hood inlet invert, and on the barrel crown D/2 downstream from the hood inlet invert. Sufficient pressures were also measured along the barrel to establish the hydraulic and friction gradelines there.

Test Apparatus and Test Procedure

Water tests

The apparatus, test procedure, and analytical methods used in the water tests were the same as those described in Part X. The barrel diameter D was 2.25 inches. The drop inlet crest was square edged and 0.089D thick. The hood length was 0.75D.

Air tests

The air apparatus and testing procedures are described in Part XI. The barrel diameter D was 3 inches. The drop inlet crest was square edged and 0.08D thick except for those tests made to evaluate the effect of crest thickness. The hood length was 0.75D.

Figure XIII–3 shows the hood inlets used in the air tests. Figure XIII–4 shows disassembled and assembled views of a hood drop inlet. The downstream end of the hood inlet section was made to match the fixed barrel entrance. The coupling shown in figure XIII–4 connects the inlet section to the barrel.

The drop inlet had an opening large enough to accommodate the thickest hood placed at the steepest barrel slope. The opening around the hood was filled with modeling clay.

Because the barrel wall thickness outside the drop inlet had no influence on the flow conditions within the drop inlet, varying the barrel wall thickness was not necessary so a fixed barrel was used outside the drop inlet. The different wall thicknesses of the hoods installed in the drop inlet simulated the different barrel wall thicknesses.

The drop inlet was mounted on a movable platform which could be adjusted to change the angle between the barrel and the drop inlet. This angle change, in effect, changed the barrel slope.

The splitter wall mounted on the drop inlet acts as an antivortex device.

Entrance Loss and Pressure Coefficient Equations

The equations for evaluating the entrance loss coefficient K_e in equation I–5 and the pressure coefficient h_n/h_{vp} in equation I–14 were developed from the Bernouli equation. Between a point on the headpool surface and the barrel exit, this equation can be written

$$\frac{V_a^2}{2g} + \frac{P_a}{w} + Z_a = \frac{V_p^2}{2g} + \frac{P_p}{w} + Z_p + h_{fr} + h_{fb} + h_e \qquad \text{(XIII-1)}$$

where the subscripts a and p represent points on the headpool surface and at the barrel exit respectively, V is the velocity, g is the gravitational acceleration, P is the pressure, w is the unit weight of water, Z is the elevation of the point, h_{fr} is the friction loss in the drop inlet, h_{fb} is the friction loss in the barrel, and h_e is the head loss attributed to the hood drop inlet.

Because the velocity in the headpool is insig-

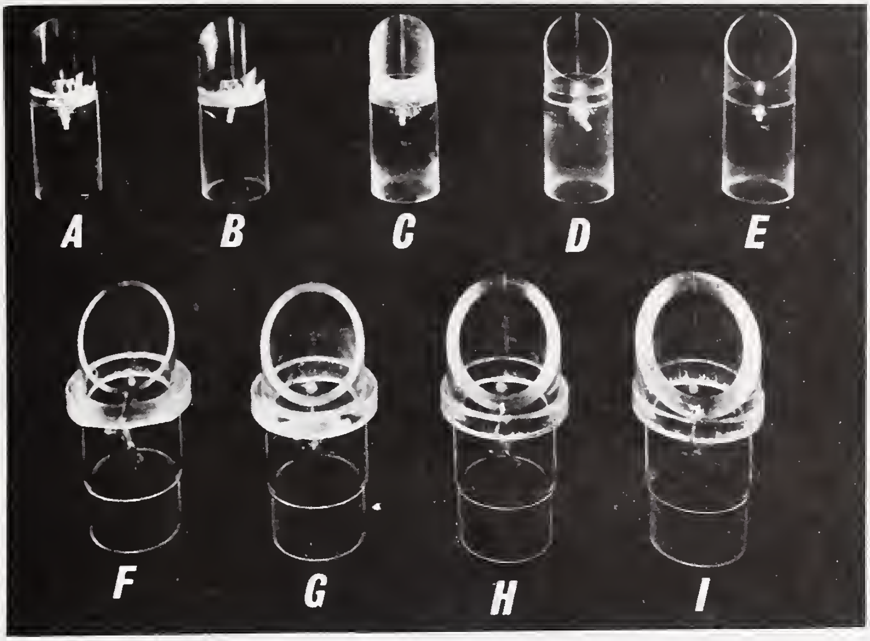


FIGURE XIII–3.—In the air tests, the hood inlets used had barrel wall thickness t_p/D of ***A***, 0.001; ***B***, 0.003; ***C***, 0.013; ***D***, 0.024; ***E***, 0.036; ***F***, 0.059; ***G***, 0.099; ***H***, 0.149; ***I***, 0.197.

nificant, the velocity head in the pool is neglected. Because the pressure at the headpool surface is atmospheric, the second term in equation XIII–1 becomes zero. Because the velocity and the flow length in the drop inlet are small, the head loss caused by friction in it can safely be neglected. Neglecting the above quantities and rearranging equation XIII–1, the head loss attributed to the entrance can be written

$$h_e = Z_o - \left(\frac{P_p}{w} + Z_p + h_{fb}\right) - \frac{V_p^2}{2g} \qquad \text{(XIII–2)}$$

The quantity inside the parentheses is the elevation Z_e of the friction gradeline at the barrel entrance. This elevation is calculated from the friction gradeline equation which is obtained by fitting a straight line through the measured pressures along the barrel. The least squares method described in Parts X and XI was used to fit the straight line.

The entrance loss coefficient K_e is defined as the ratio of the total energy loss caused by the entrance to the velocity head in the barrel and can be written

$$K_e = \frac{h_e}{V_p^2 / 2g} \qquad \text{(XIII–3)}$$

Substituting equation XIII–2 and Z_e into equation XIII–3, the equation for the entrance loss coefficient becomes

$$K_e = \frac{(Z_o - Z_e)}{V_p^2 / 2g} - 1 \qquad \text{(XIII–4)}$$

The pressure efficient h_n/h_{vp} is defined as the ratio of the difference between the pressure head at any point n and the pressure head computed from the friction gradeline at the same point to the velocity head in the barrel. This ratio can be written

$$\frac{h_n}{h_{vp}} = \frac{\Delta P_n / w}{V_p^2 / 2g} \qquad \text{(XIII–5)}$$

where ΔP_n is the difference between the pressure at point n and the pressure computed from the friction gradeline.

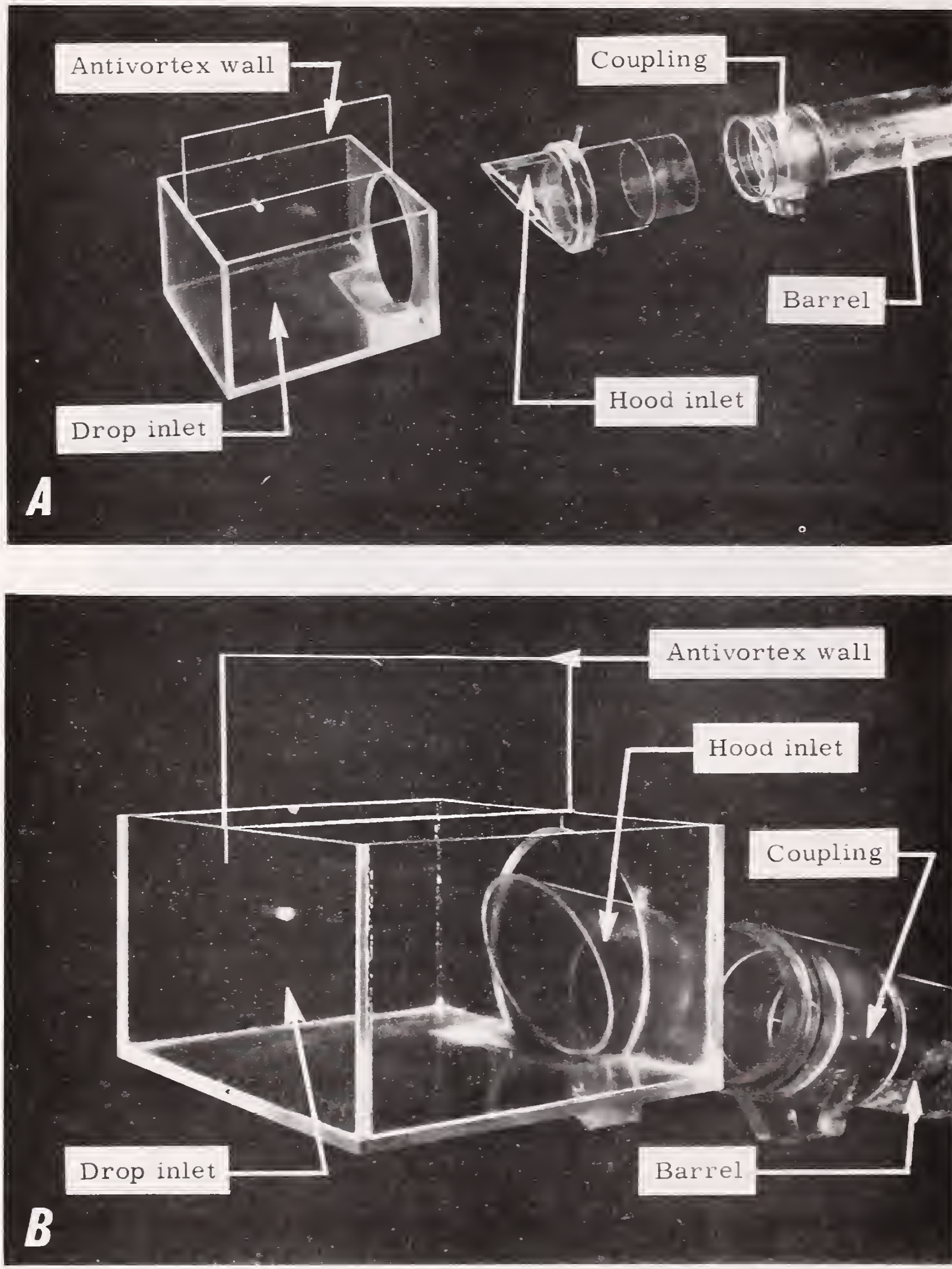


FIGURE XIII-4.—The hood drop inlet assembly: *A*, disassembled; *B*, assembled.

Test Results

The experimental results report the performance of hood drop inlets and the effect of discharge, crest thickness, barrel wall thickness, barrel slope, drop inlet size, and drop inlet height on the entrance loss and pressure coefficients for square drop inlets with reentrant and flush entrance hoods, and circular drop inlets with reentrant hoods. The precision with which the

equations summarizing the results represent the experimental results is discussed.

Performance

The spillway performance was evaluated from test notes based on visual observation of the priming process and from the headpool water level recorder charts. Criteria for satisfactory hood drop inlet performance were smooth priming of the spillway and the absence of headpool water level fluctuations.

The performance tests were conducted using the water apparatus. Drop inlet sizes and heights used in these water tests are listed in table XIII–1. A 0.056D-thick barrel with a 0.75D-long hood entrance was used for all water tests. The barrel slope was 20 percent.

During the performance tests, the head H over the crest of the drop inlet at which the barrel primed or first tried to prime was determined for each drop inlet. The variation of this priming head with the drop inlet height for different drop inlet sizes and shapes is shown in figure XIII–5.

The points p in figure XIII–5 and 3, 3, and 4 in the Notes column of tables XIII–7, XIII–8, and XIII–9 (appendix), respectively, indicate that although the barrel primed or was forced to prime by the observer, the flow alternated between part full and full pipe flow. The drop inlets represented by p points do not have a unique head-discharge relationship, and their performance is therefore poor.

The points b in figure XIII–5 and 5, 4, and 5 in tables XIII–7, XIII–8, and XIII–9, respectively, indicate that the headpool water level recorder charts showed there was a slight rise in the headpool level before the barrel primed. After the initial attempt to prime the barrel, with increasing flow the head-discharge relationship passes through slug flow and full pipe flow stages. The drop inlets represented by these b points show performances bordering between poor and satisfactory.

The points h in figure XIII–5 and 6 in tables XIII–7 and XIII–9 indicate that the charts showed there was a slight fluctuation in the headpool surface. However, the performance is considered to be satisfactory. The drop inlets represented by the nondesignated points and 1 in tables XIII–7, XIII–8, and XIII–9 have a unique head-discharge relationship, and their performance is satisfactory.

Figure XIII–5 shows three regions: high drop inlets, $Z_l/D \geqq 1.25$, where the head over the drop inlet crest controls the barrel priming; low drop inlets, $Z_l/D \leqq 1$, where the head over the hood inlet invert, $H/D + Z_l/D$, largely controls the barrel priming; and medium height drop inlets, $1 < Z_l/D < 1.25$, where the head control for barrel priming changes between the hood inlet invert and the drop inlet crest.

For satisfactory performance the minimum drop inlet size B for high drop inlets, $Z_l/D \geqq 1.25$, is the 1.5D square or 2D in diameter with a reentrant hood and 1.25D square with a flush entrance hood. The minimum size for satisfactory performance of the low drop inlets, $Z_l/D \leqq 1$, tested is 4D square or 3.77D in diameter with a reentrant hood and 1.5D square with a flush entrance hood. (Probably the minimum size for satisfactory performance of low drop inlets with a reentrant hood is less than that specified in the previous sentence. But, because no reentrant hood drop inlets between 2D and 4D square or 1.98D and 3.77D in diameter were tested, there are no data available to determine what the smaller minimum permissible size might be.)

Despite the absence of data, the authors suggest that the minimum drop inlet size established for the low drop inlets be used for the medium height drop inlets, $1 < Z_l/D < 1.25$.

The lesser minimum drop inlet size for the flush entrance hood is expected because the flush entrance hood does not project into the drop inlet as does the reentrant hood. Therefore, the flush entrance hood gives a larger flow area in the drop inlet and a better approach to the barrel entrance. The increase in the minimum drop inlet size for low drop inlets is because the flow disturbances, caused by the drop inlet crest and the reentrant hood, interact and are greater for low drop inlets than for high drop inlets.

For drop inlets greater than the minimum size and equal to or less than 1D high ($Z_l/D \leqq 1$), the priming head decreases linearly with an increase in the drop inlet height but is the same for all sizes. For drop inlets of adequate size and equal to or greater than 1.25D high ($Z_l/D \geqq 1.25$), the priming head decreases with an increase in drop inlet size but remains the same for all heights.

The equations for computing the priming heads for adequate size drop inlets follow.

When there is no drop inlet ($Z_l/D = 0$) the priming head can be computed from equation

X–1. Experimental data obtained during both the hood inlet and the hood drop inlet tests indicate that the barrel will prime when $Q/D^{5/2}$ is about 6 if there is no drop inlet.

Using $Q/D^{5/2} = 6$ in equation X–1, the priming head H/D becomes 1.20; this is taken as the initial point on the priming head-drop inlet height relationship as shown in figure XIII–5. Assuming

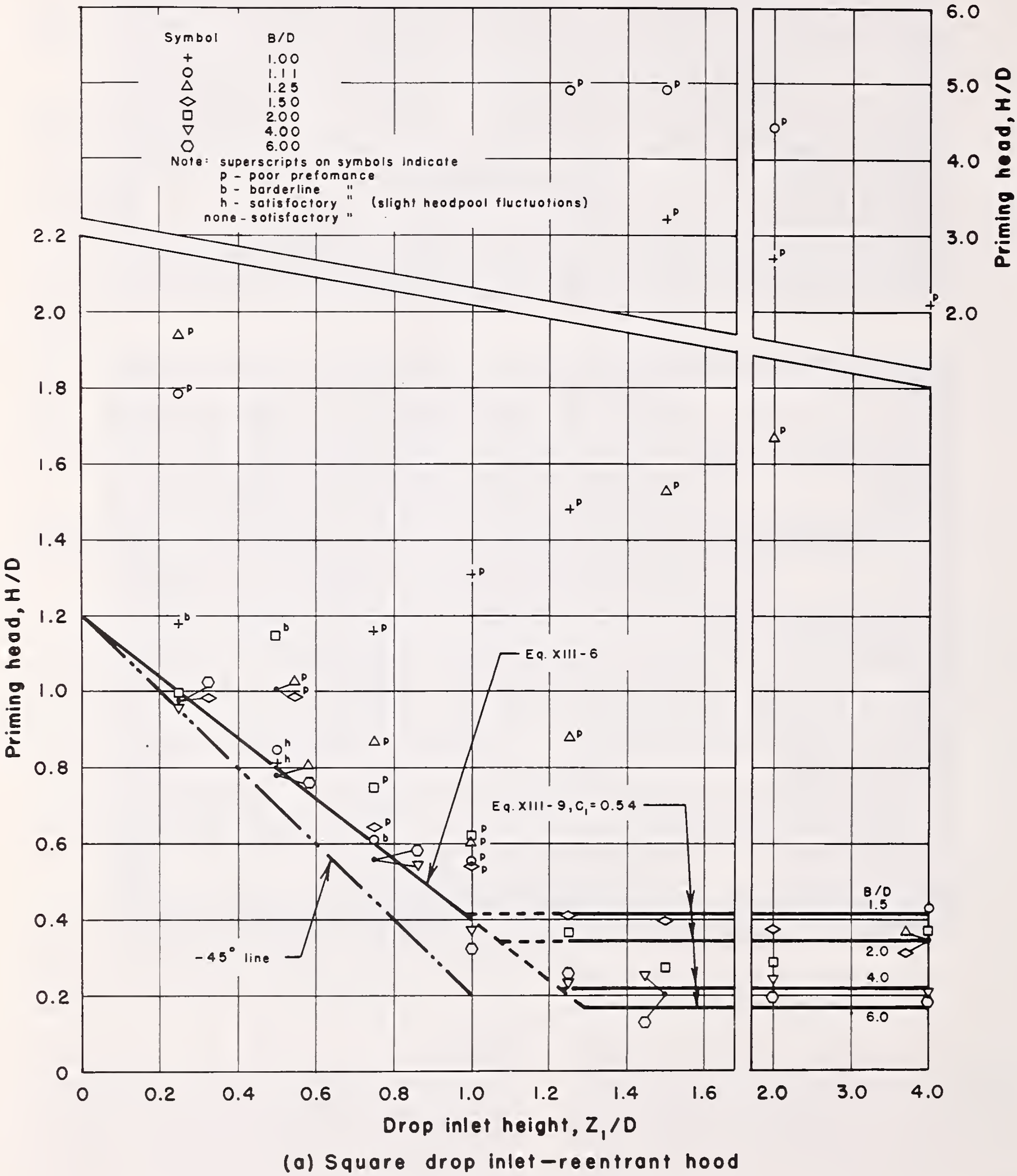
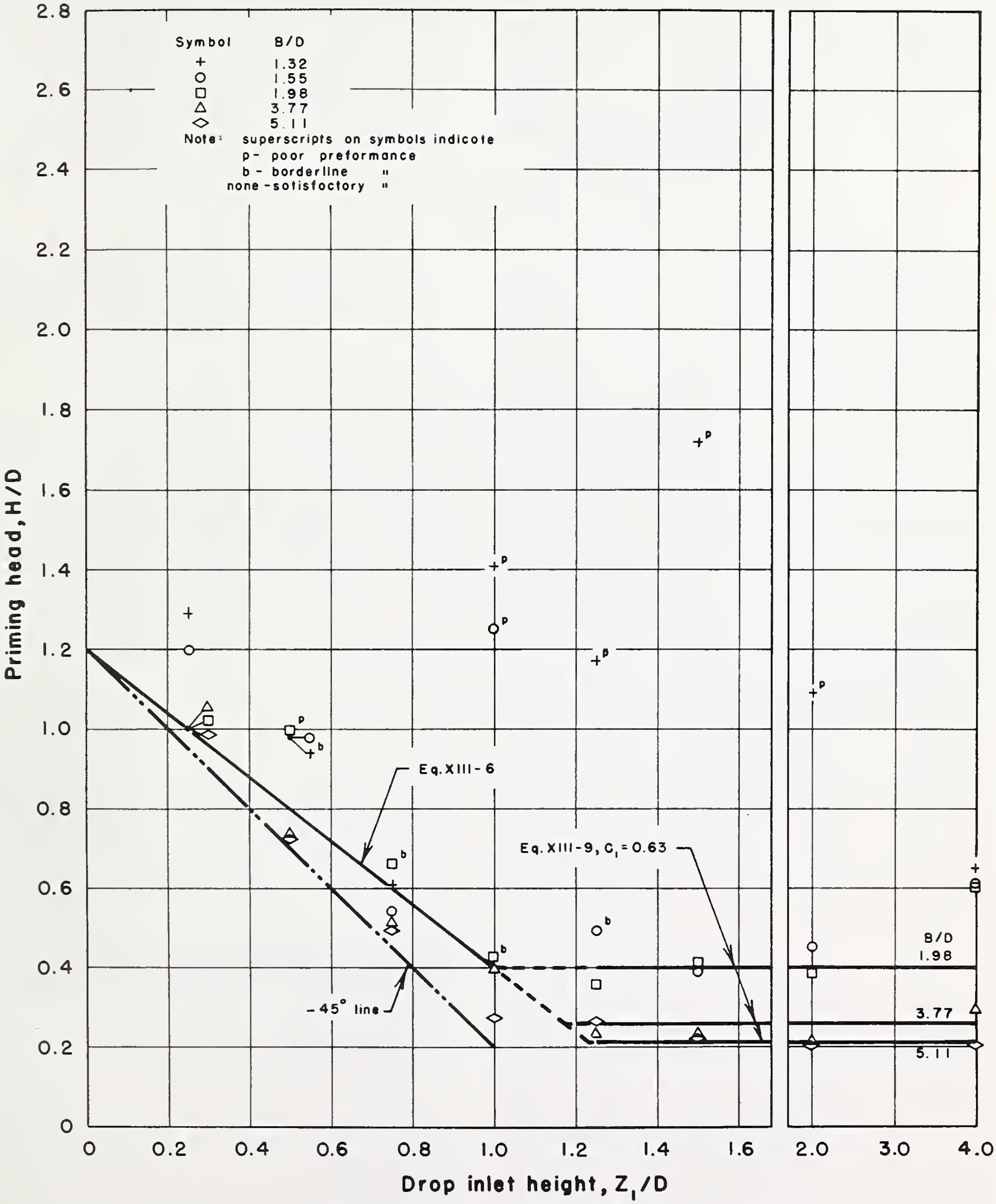


FIGURE XIII–5.—Performance of the hood drop inlets.

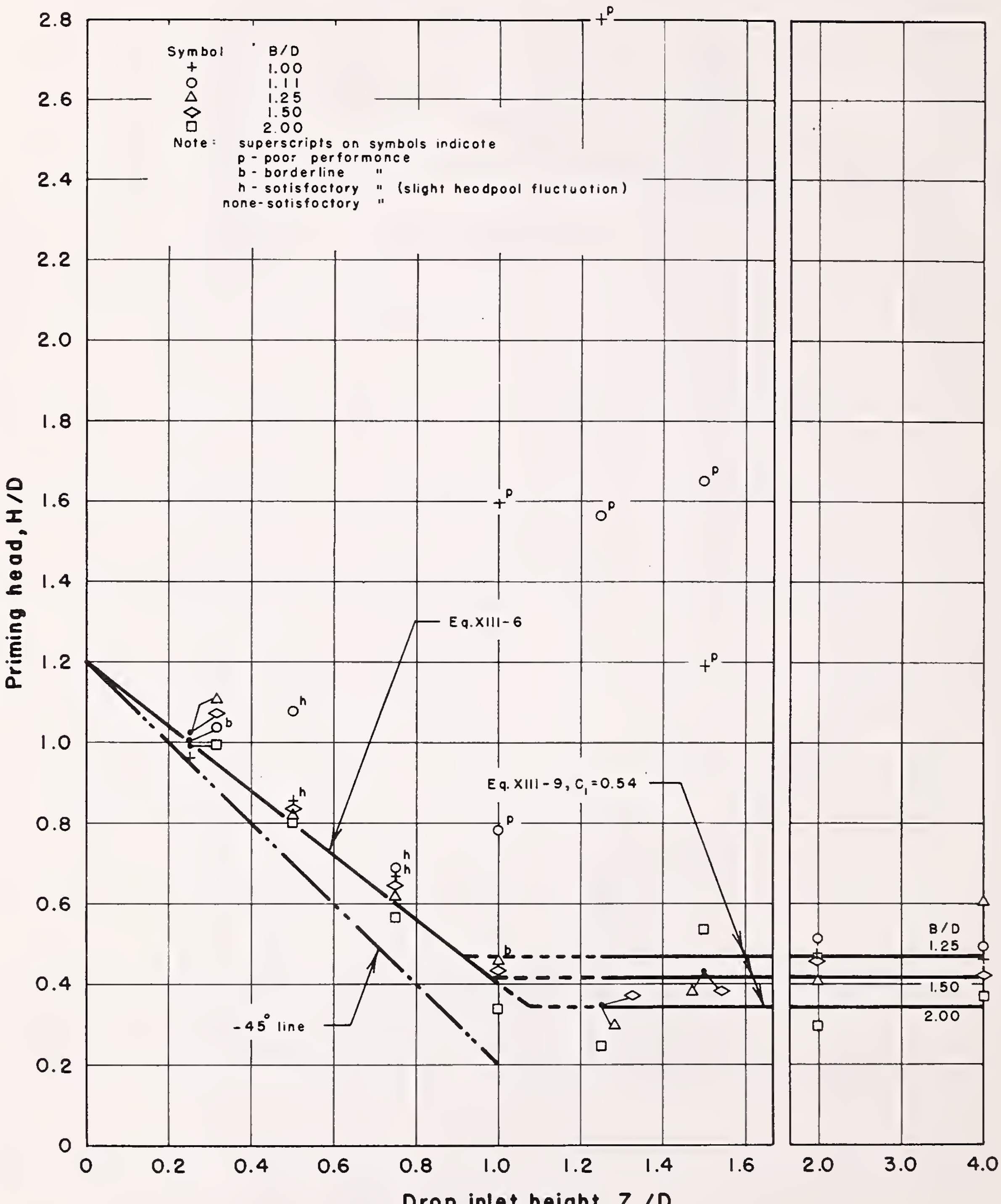
that the drop inlet has no effect, the long dash-double dot line through this point (0, 1.2) with a slope of -1.0 ($-45°$) represents the theoretical priming head for $Z_l/D \leqq 1$. This line shows that the sum of the drop inlet height and the priming head over the drop inlet crest gives a pool level which is at 1.20D above the hood invert thus indicating that the hood inlet rather than



(b) Circular drop inlet—reentrant hood

FIGURE XIII-5.—Continued.

the drop inlet crest controls the priming head. However, the solid line with a slope of −0.8 plotted in figure XIII–5 represents the data and gives slightly higher priming heads. The reason for the higher priming heads is that the drop inlet disturbs the flow near the hood inlet. The equation for computing the priming head for low drop inlets is



(c) Square drop inlet—flush entrance hood

FIGURE XIII–5.—Continued.

$$\frac{H}{D} = 1.2 - 0.8\frac{Z_1}{D} \qquad \text{(XIII-6)}$$

for $Z_1/D \leqq 1$.

The priming head for high drop inlets of adequate size depends on the drop inlet crest length. When $Z_1/D \geqq 1.25$ and the discharge is sufficient for priming, the water depth in the drop inlet always becomes 1.20D or greater, thus assuring priming of the barrel. Therefore, the drop inlet crest acting as a weir controls the head-discharge relationship when the barrel primes. So the equation for computing the priming head is derived from the weir flow equation

$$Q = C\,L\,H^{3/2} \qquad \text{(XIII-7)}$$

where C is the weir coefficient and L is the weir length—$4B$ for a square drop inlet and πB for a circular drop inlet. Dividing equation XIII-7 by $D^{5/2}$, the weir flow equation becomes

$$\frac{Q}{D^{5/2}} = C\left(\frac{L}{D}\right)\left(\frac{H}{D}\right)^{3/2} \qquad \text{(XIII-8)}$$

Substituting $\left(\frac{L}{B}\right)\left(\frac{B}{D}\right)$ for $\left(\frac{L}{D}\right)$ in equation XIII-8 and rearranging the terms, the priming head is expressed as a function of the drop inlet size. The equation for computing the priming head over the drop inlet crest is written

$$\frac{H}{D} = C_1\left(\frac{B}{D}\right)^{-2/3} \qquad \text{(XIII-9)}$$

where $C_1 = \left(\frac{Q/D^{5/2}}{C\,L/B}\right)^{2/3}$. The value of C_1 is determined from the experimental data and equals 0.54 for square drop inlets and 0.63 for circular drop inlets. Equation XIII-9 has been plotted in figure XIII-5 and shows satisfactory agreement between the equation and the experimental results.

Possible priming heads for medium height drop inlets, $1.0 < Z_1/D < 1.25$, are shown by short dash lines in figure XIII-5. Since the heights of these drop inlets are between the selected step increment in heights for the experiments, $Z_1/D = 1.0$ and 1.25, no data are available to define the priming head and no attempt is made to derive equations for computing the priming heads. However, possibly equations XIII-6 or XIII-9 can be extended to estimate the priming head for medium height drop inlets as indicated by the dash lines in figure XIII-5.

Entrance loss coefficients

In the following sections the entrance loss coefficient data for a square drop inlet with a reentrant hood, a circular drop inlet with a reentrant hood, and a square drop inlet with a flush entrance hood are presented: Equations for design use are developed; and the precision of the equations—a comparison of the experimental and equation values—is evaluated. In addition the effects of the drop inlet elements on the entrance loss coefficient are discussed.

Square drop inlet—reentrant hood

The variables tested in the study of the square drop inlet with a reentrant hood were the discharge, crest wall thickness, barrel wall thickness, barrel slope, drop inlet size, and drop inlet height. The magnitudes and ranges of the variables appear in the Experimental Program section. The results are summarized in tables XIII-5 (appendix) for the air tests and in table XIII-7 (appendix) for the water tests.

Effect of discharge.—Several experimental runs, each with a different discharge, were made and the entrance loss coefficients were computed. The barrel Reynolds number $\mathbf{R} = V_pD/\nu$ varies with the discharge, so this parameter is used to evaluate the effect of discharge on the entrance loss coefficient. Figure XIII-6 is a typical plot showing this effect for several relative drop inlet sizes B/D and relative barrel wall thicknesses t_p/D. The data presented show that the entrance loss coefficient is independent of the Reynolds number. A similar effect of the Reynolds number is evident in all the other results. Therefore, the entrance loss coefficients computed from the several discharges used in each test series were averaged and used for all subsequent analyses. These average values are given in tables XIII-5 through XIII-9 (appendix).

Because the prototype Reynolds numbers are an order of magnitude greater than those obtainables in the laboratory, the lack of variation of the entrance loss coefficient with the Reynolds number indicates that the entrance loss coefficients obtained in the laboratory can be applied directly to prototype structures.

Effect of crest wall thickness.—The effect of the crest thickness on the entrance loss coefficient was determined from the results of 56 air tests conducted using different combinations of nine

crest thicknesses, five barrel wall thicknesses, and two drop inlet sizes. The data are plotted in figure XIII–7 and listed in table XIII–5 (appendix).

The data in figure XIII–7 show that the entrance loss coefficient is independent of the crest wall thickness or of the presence or absence of a berm level with the crest.

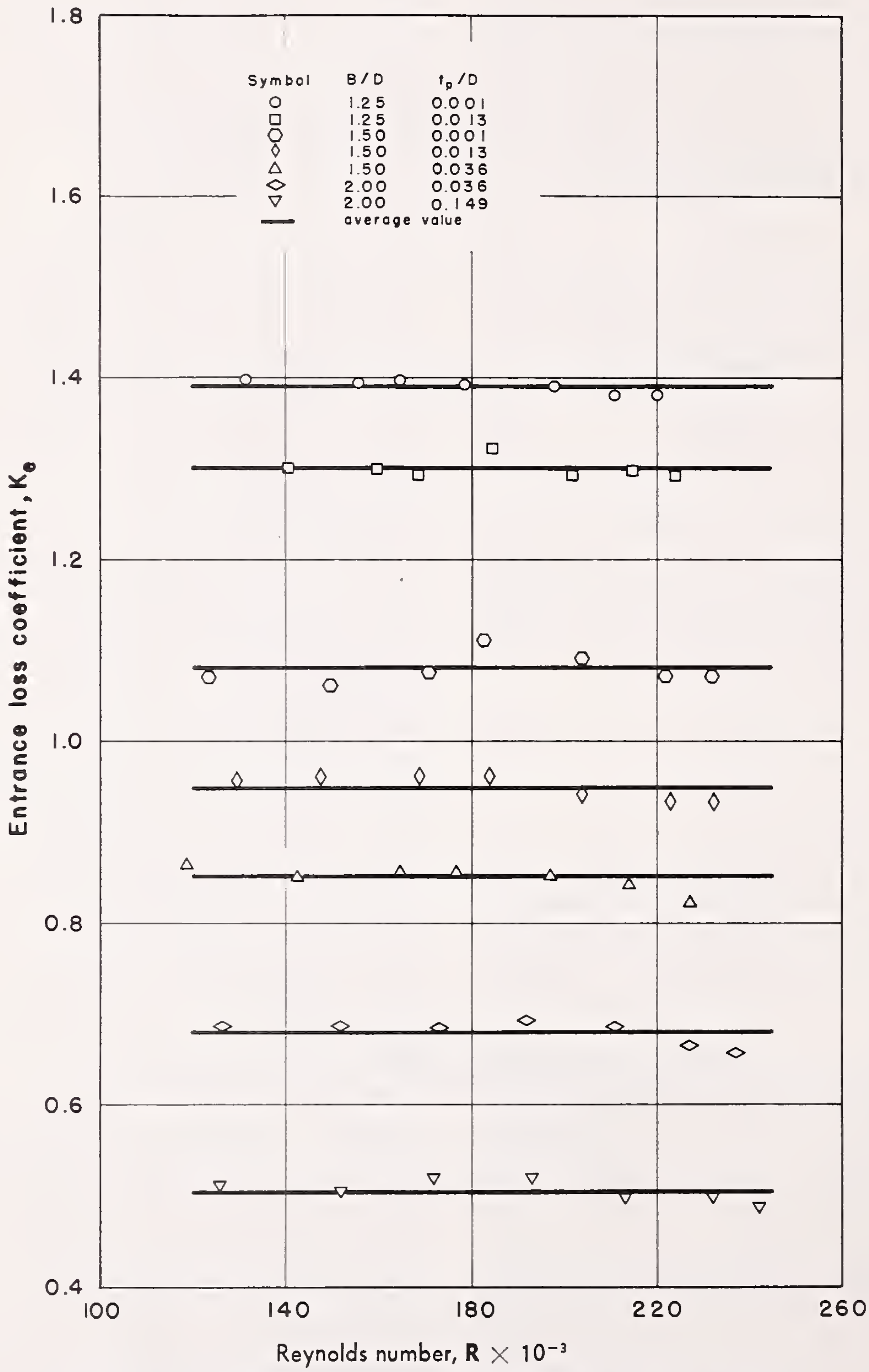


FIGURE XIII–6.—The effect of barrel Reynolds number on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_i/D = 5.0$, $S = 0.20$.

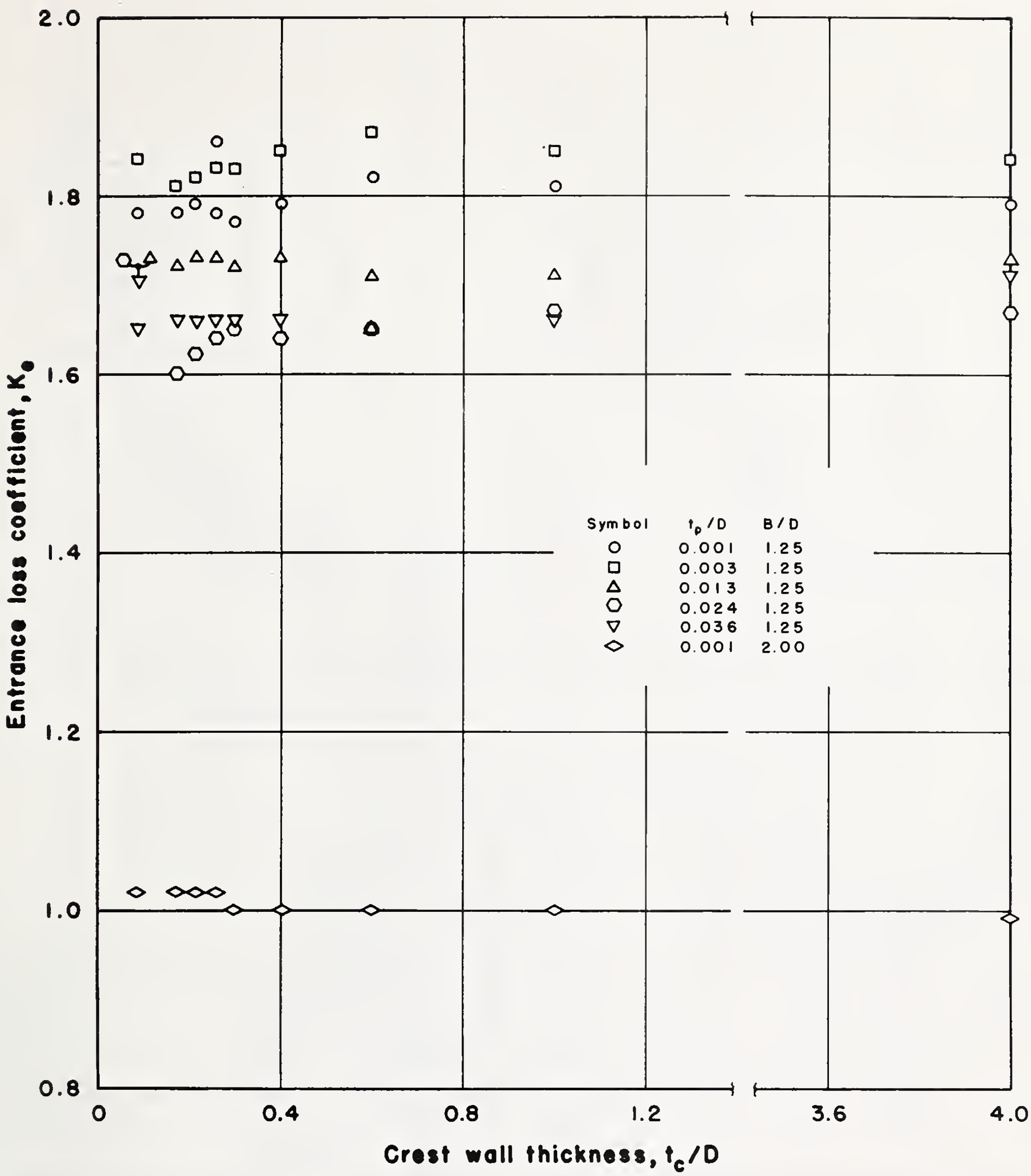


FIGURE XIII-7.—The effect of crest wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_1/D = 5.00$, $S = 0.00$.

Effect of barrel wall thickness.—The hood inlet study (Part X) showed that the barrel wall thickness does not affect the performance of the inlet but does affect the energy loss at the inlet. Therefore, in this hood drop inlet study the entrance loss coefficients for nine barrel wall thicknesses ranging from 0.001D to 0.197D were obtained using the air apparatus. Pertinent data, graphs, explanations, and equations representing results are in this section.

Figures XIII–8 through XIII–16 show the effects of the barrel wall thickness on the entrance loss coefficient. These figures show two regions—a thin barrel region where the entrance loss coefficient decreases linearly as the wall thickness increases, and a thick barrel region where the entrance loss coefficient is constant for all barrel thicknesses. The barrel wall thickness separating the thin and thick wall regions is defined as the critical barrel wall thickness, $t_{p,cr}$.

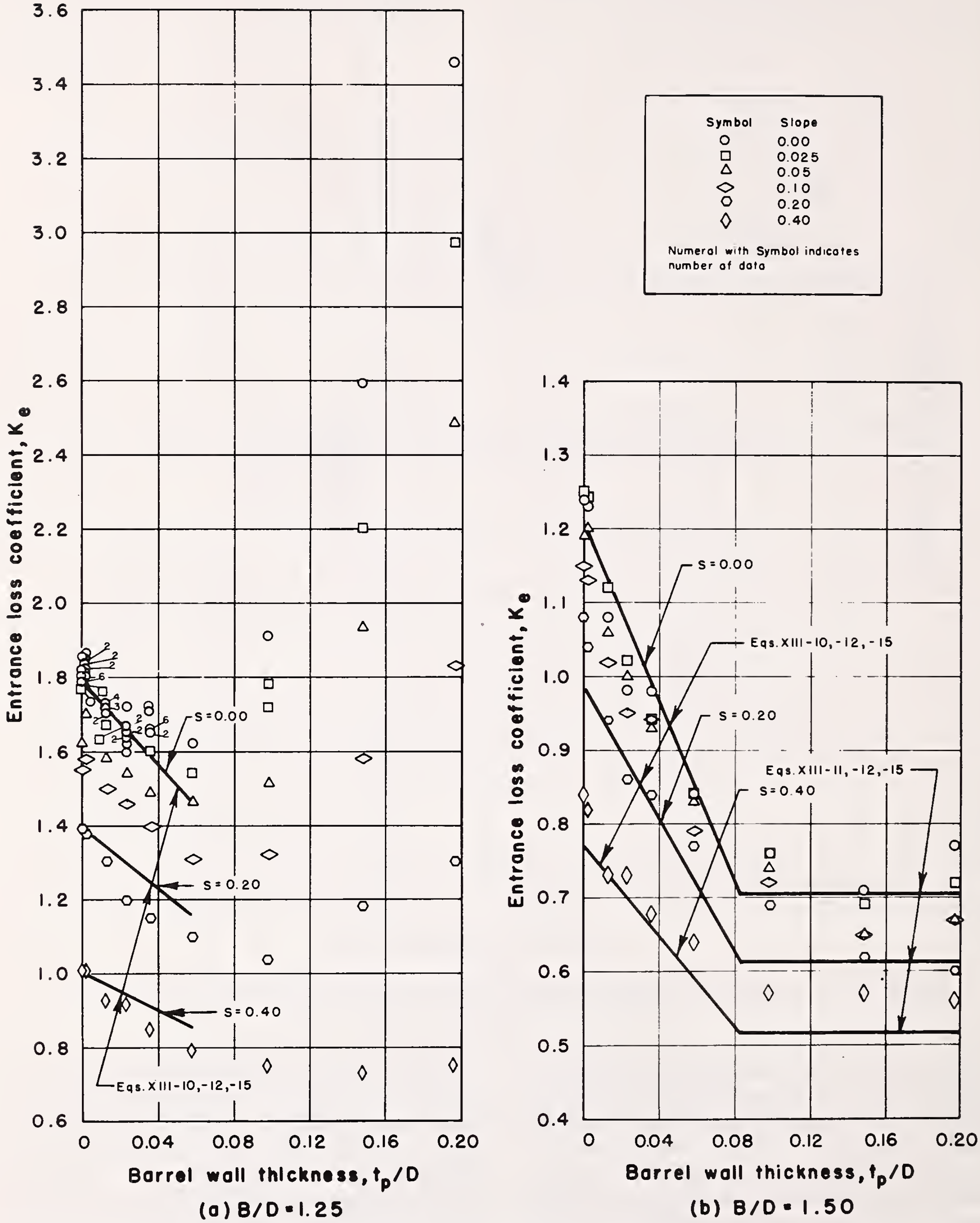


FIGURE XIII-8.—The effect of barrel wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_i/D = 5.00$.

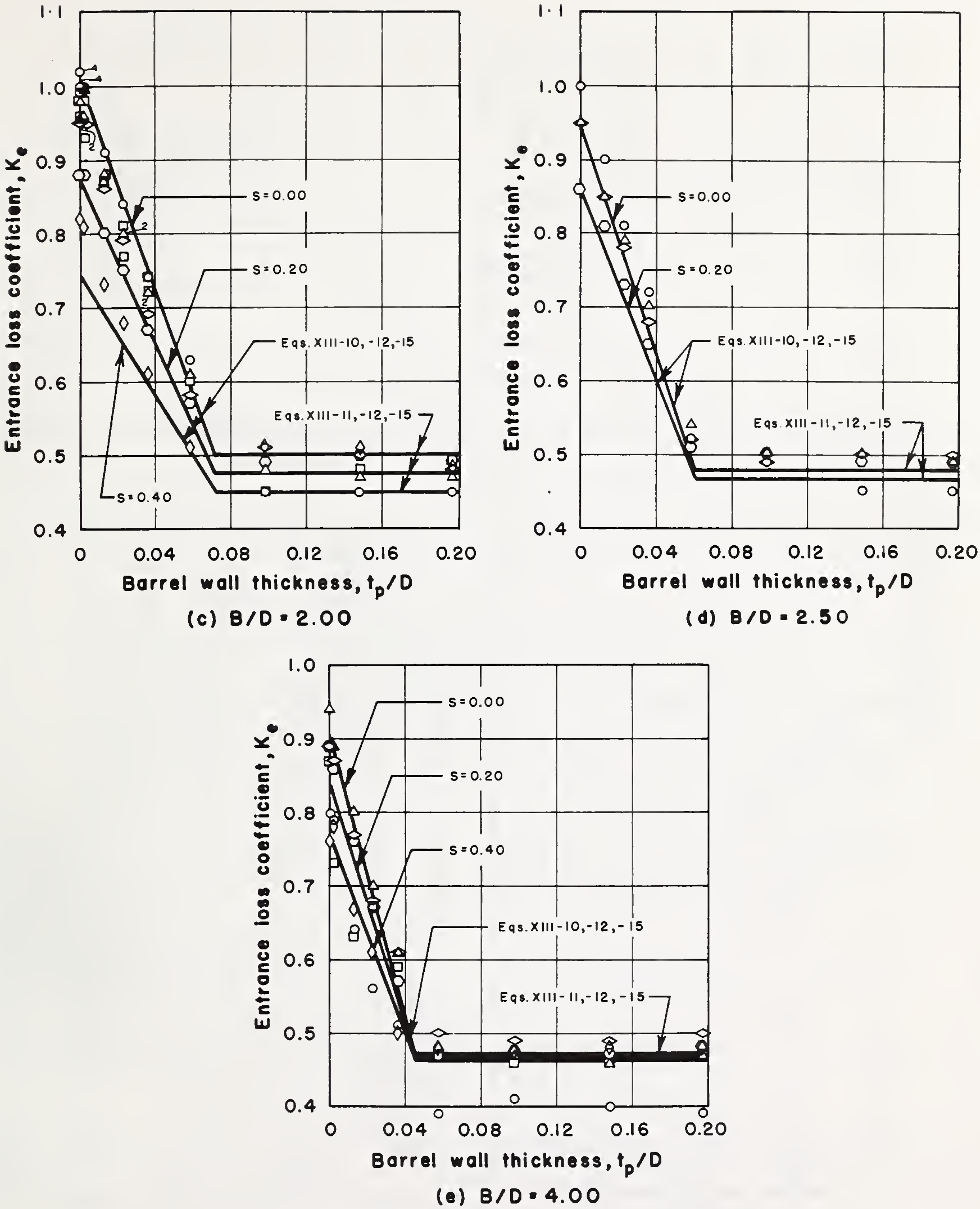


FIGURE XIII-8.—Continued.

Harris[3] also found two regions in his study of the effect of the barrel wall thickness on the entrance loss coefficient for a square-edged re-

[3] HARRIS, C. W. The influence of re-entrant intake losses. Univ. of Wash. Engin. Exp. Stn., Bul. No. 48, 35 pp. 1948.

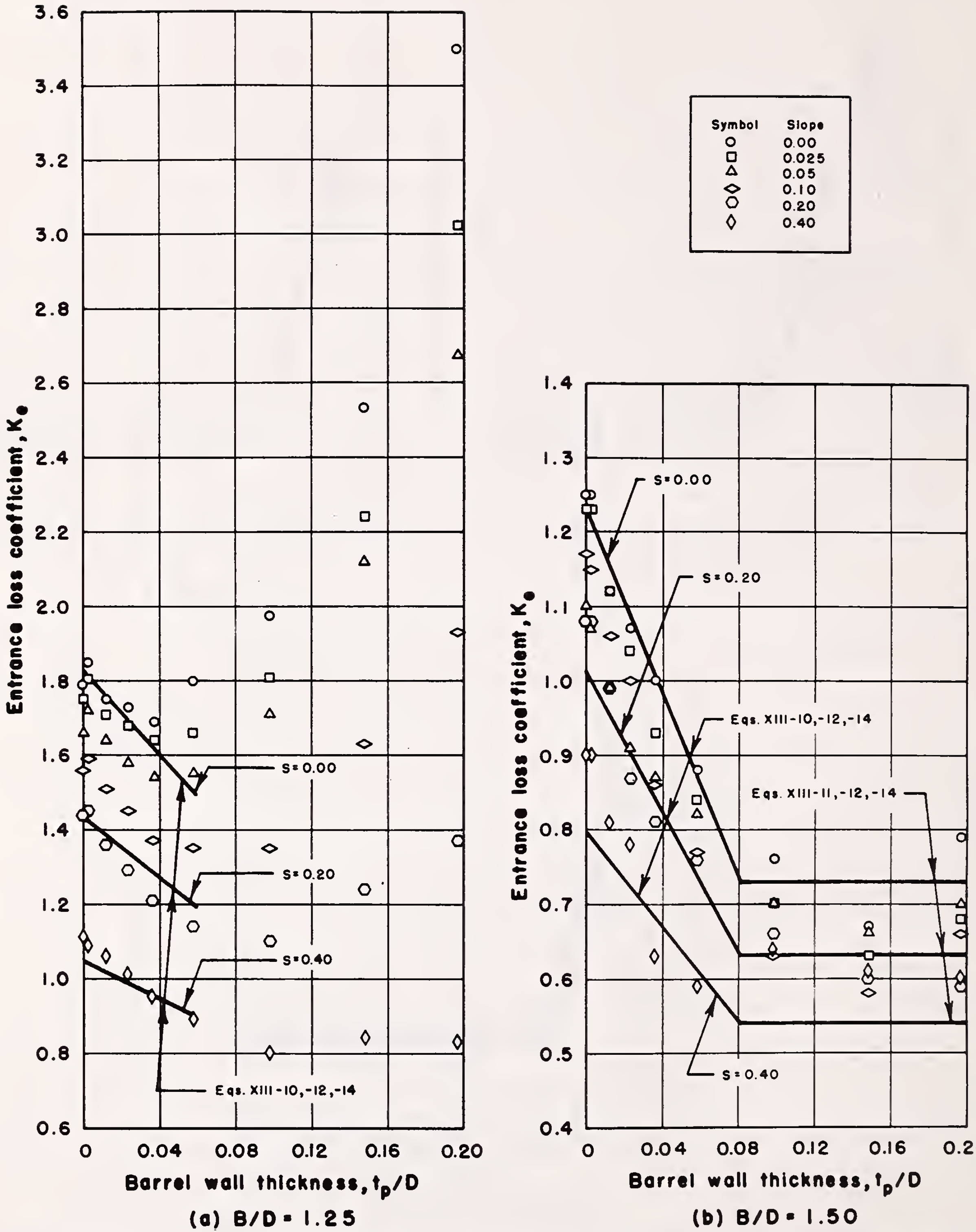


FIGURE XIII-9.—The effect of barrel wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_i/D = 3.00$.

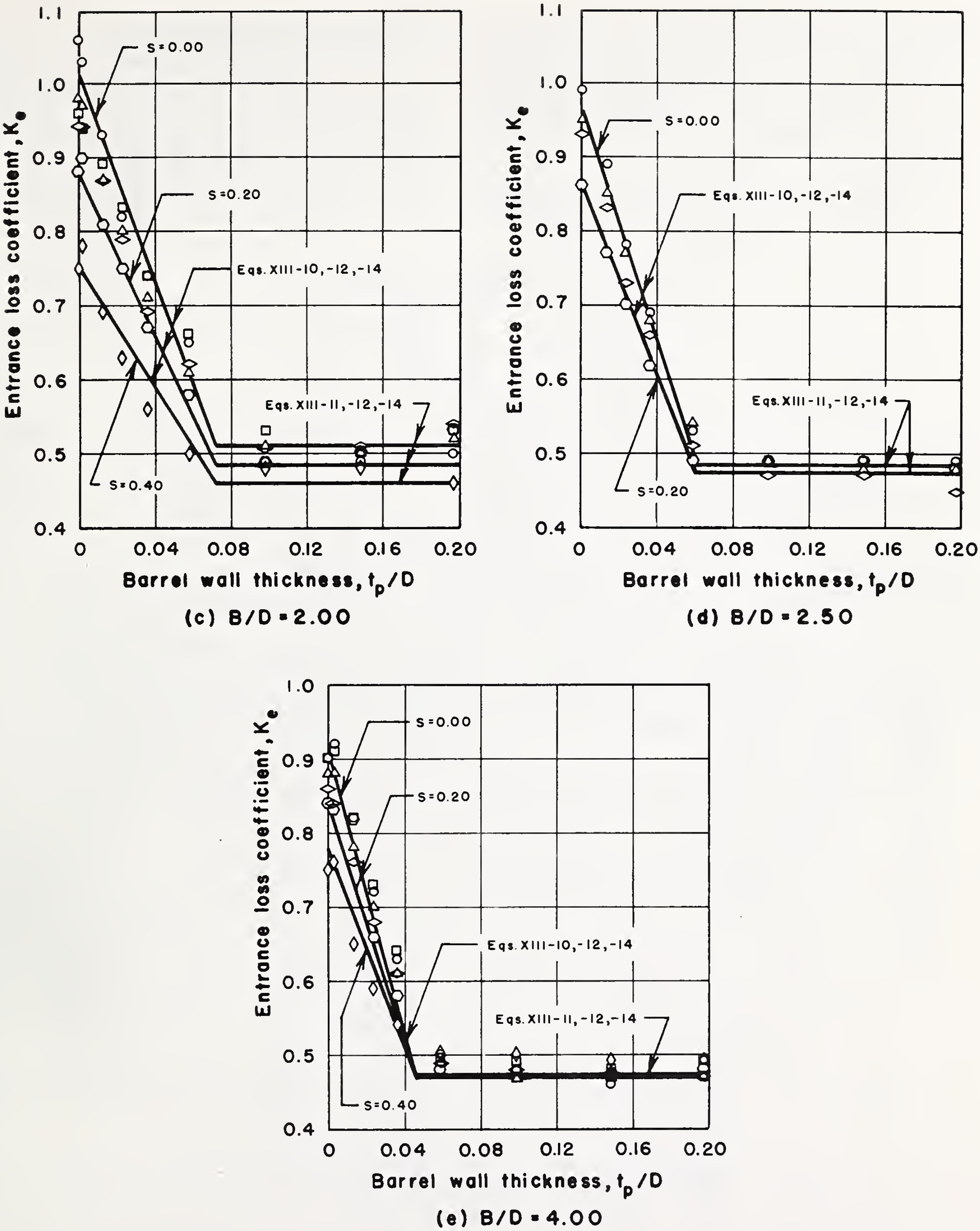


FIGURE XIII-9.—Continued.

entrant intake from an infinitely large tank. Figure XIII-16 shows a curve summarizing the theoretical results obtained by Harris for a square-edged reentrant barrel. Equation X-7 for a hood inlet is also shown in figure XIII-16. Both Harris' results and equation X-7 show

the same trend for the effect of the barrel wall thickness on the entrance loss coefficient as do the results of the tests reported here. However, the entrance loss coefficients reported in Part X are higher than those observed in this study.

The reason why the entrance loss coefficient varies with the barrel wall thickness is explained in the following paragraphs.

The major portion of the entrance energy loss originates near the barrel entrance where the flow expands from the vena contracta to full pipe flow. Figure XIII–17(a) shows that when the barrel is thin, the boundary streamline at the barrel crown separates from the outside edge of the barrel, enters the barrel forming the vena con-

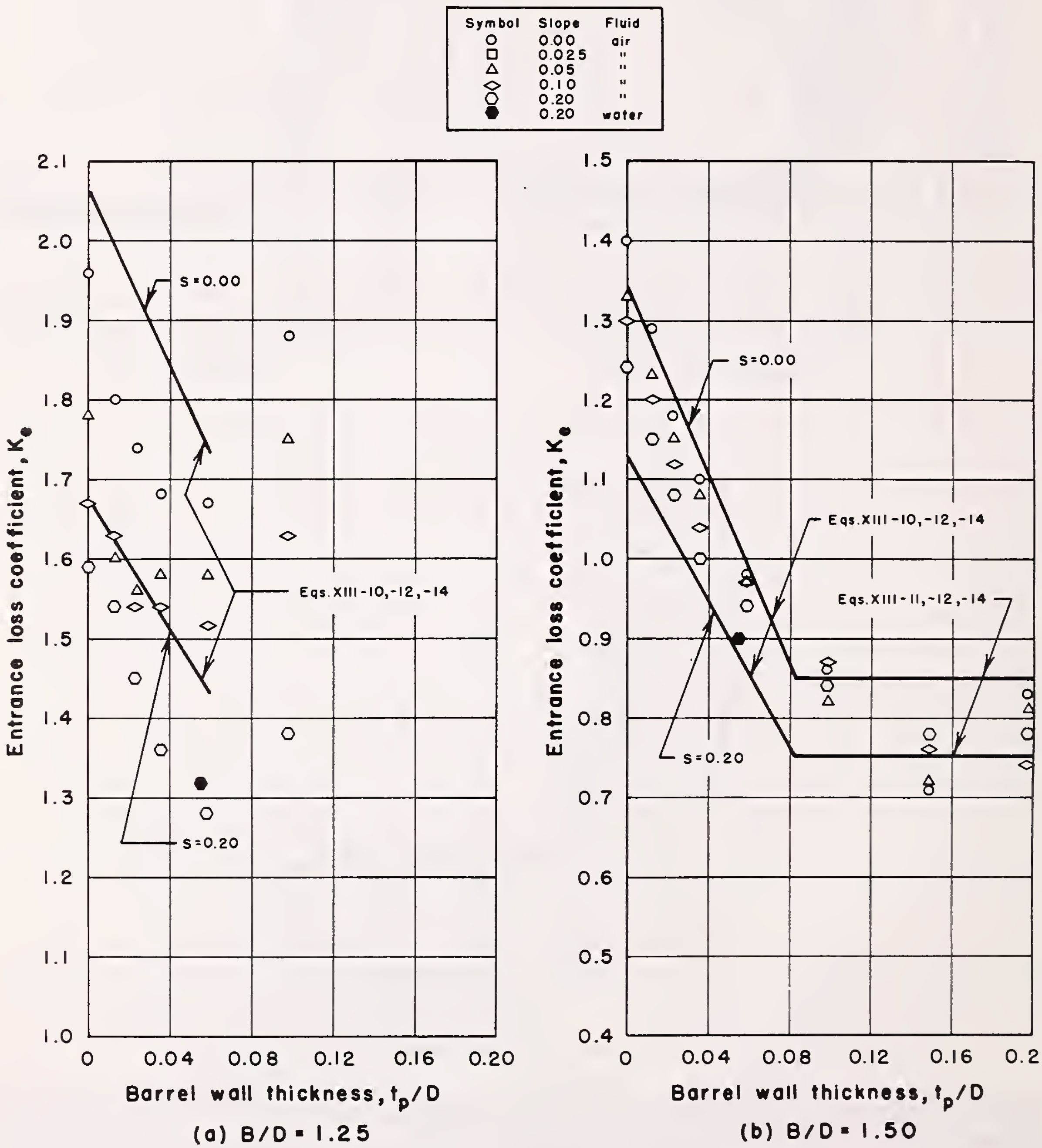


FIGURE XIII–10.—The effect of barrel wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_l/D = 1.50$.

tracta, and expands and reattaches to the barrel inside wall farther downstream.

As the barrel wall thickness increases, space available for expansion of the vena contracta decreases so there is less jet expansion and less energy loss. Eventually, the vena contracta oc-

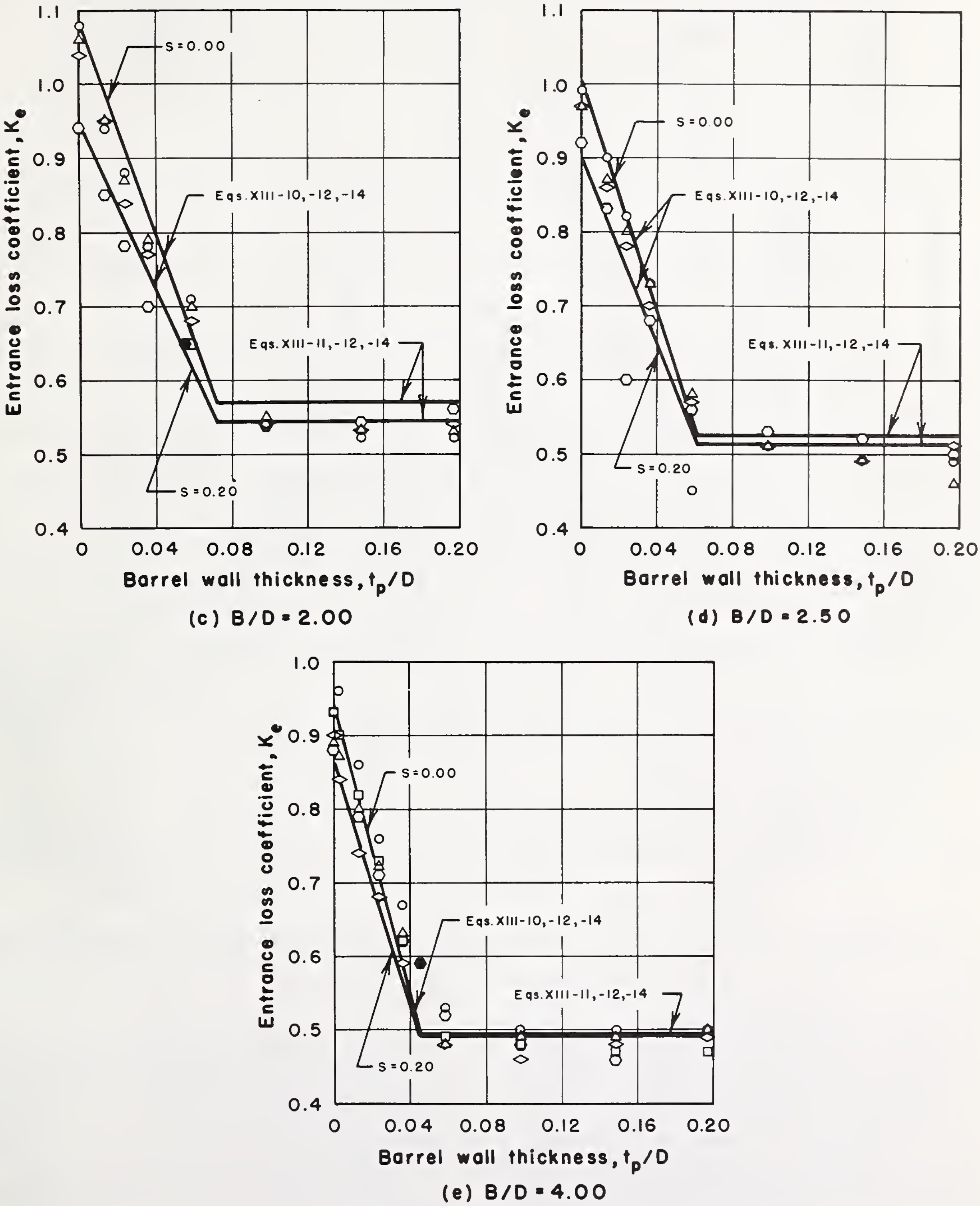


FIGURE XIII-10.—Continued.

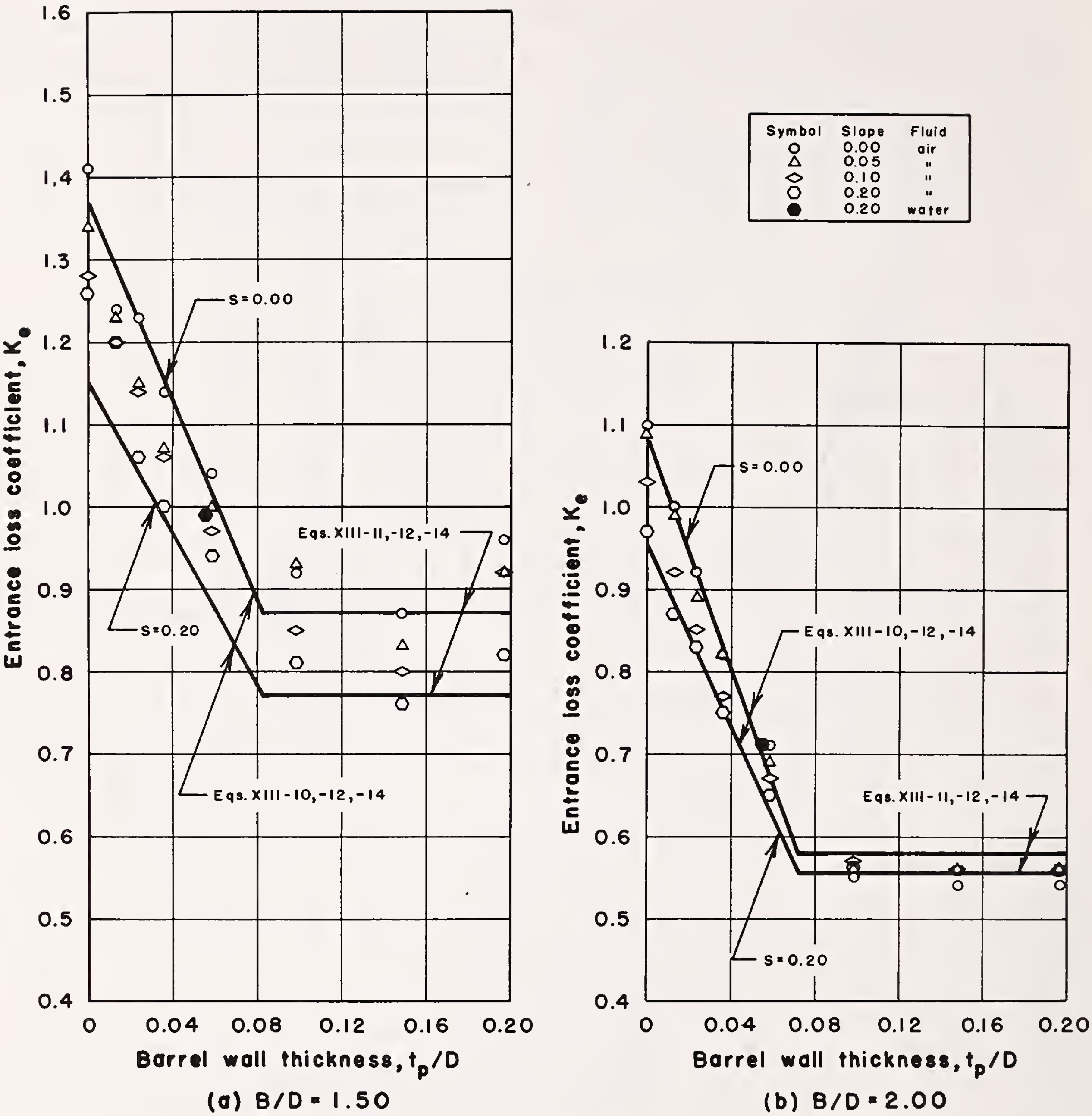


FIGURE XIII–11.—The effect of barrel wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_l/D = 1.25$.

cupies the full barrel diameter as shown in figure XIII–17(b) so there is no jet expansion and zero energy loss.

With further increase in the barrel wall thickness, figure XIII–17(c) shows that the boundary streamline first separates from the outside edge of the barrel and then reattaches to the face of the hood inlet. As the flow enters the barrel, this boundary streamline separates again from the inside edge of the barrel forming the vena contracta and then reattaches to the barrel inside wall farther downstream. For thick barrels, this streamline pattern remains the same resulting in an identical energy loss for all thick barrels.

The flow patterns described above indicate that as the barrel wall thickness increases, the en-

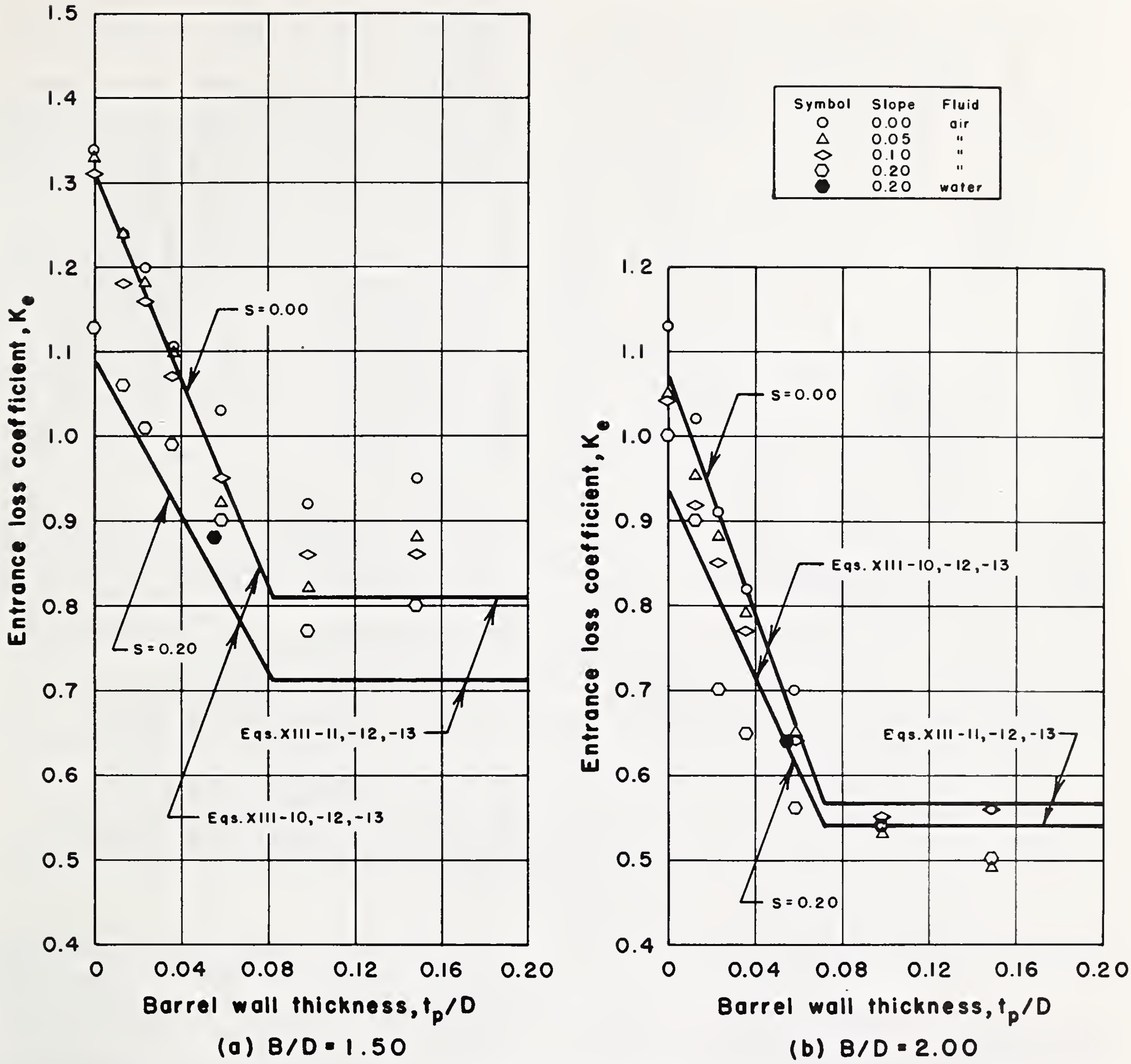


FIGURE XIII-12.—The effect of barrel wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_l/D = 1.00$.

trance energy loss decreases until it becomes zero, then increases to a constant value that represents the energy loss for thick barrels. In real flows, however, the entrance energy loss neither becomes zero nor increases suddenly. Instead, the entrance energy loss decreases with an increase in the barrel wall thickness for thin barrels, $t_p/D < t_{p,cr}/D$; reaches a minimum value for the critical barrel wall thickness, $t_p/D = t_{p,cr}/D$; and is constant for all thick barrels, $t_p/D > t_{p,cr}/D$.

Figures XIII–8 through XIII–16 show that for an adequate size drop inlet, $B/D \geqq 1.5$, the entrance loss coefficient is constant for all thick barrels, $t_p/D \geqq t_{p,cr}/D$. But for small drop inlets, $B/D = 1.25$, with thick barrels figures XIII–8(a), XIII–9(a), and XIII–10(a) show that the entrance loss coefficient increases with an increase in the barrel wall thickness. This is because the thick hood barrel entrance reduces the flow area in the drop inlet and causes choking flow conditions near the barrel entrance. This choked flow creates high energy loss and results in a poor

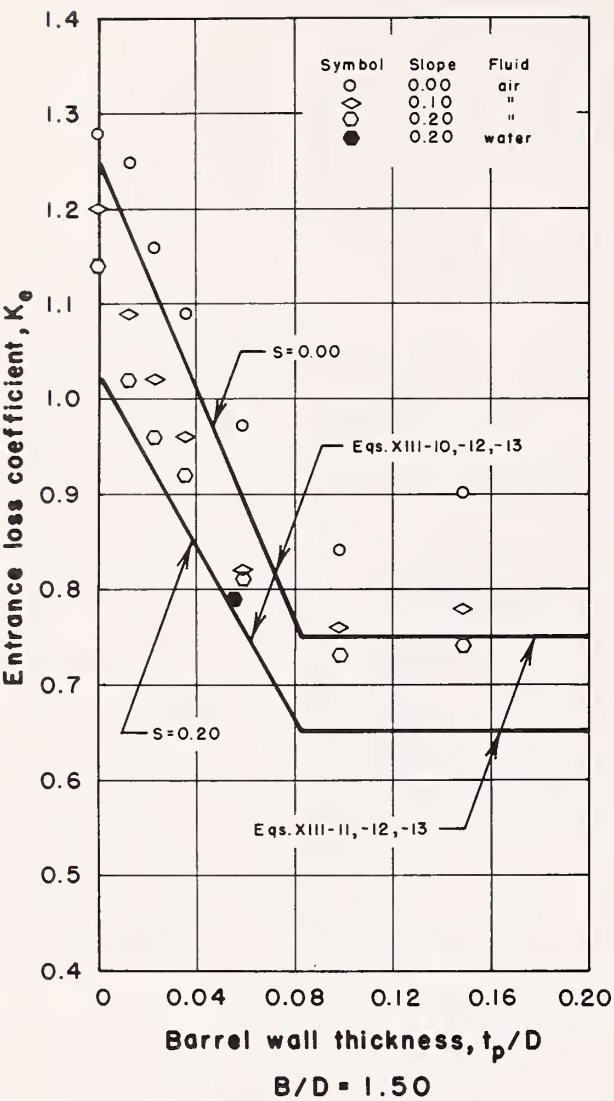


FIGURE XIII-13.—The effect of barrel wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_i/D = 0.75$.

performance of the small drop inlet.

The critical barrel wall thickness varies with the drop inlet size. This is shown in figures XIII-8(b) through XIII-8(e) where the critical barrel wall thickness progressively decreases from 0.082D for the 1.5D-square drop inlet to 0.045D for the 4D-square drop inlet. The reason for the variation in the critical wall thickness with drop inlet size is illustrated in figure XIII-18 which shows the flow pattern approaching the barrel entrance for two sizes of drop inlets. As the drop inlet size decreases, the velocity approaching the barrel entrance increases and its direction changes, producing more contraction and a smaller jet.

Because the critical barrel wall thickness is the minimum thickness needed for the boundary streamline separated from the barrel extrados crown to reattach to the face of the hood inlet (see figure XIII-17(b)) and because the space between the barrel inside wall and the vena contracta (the contraction) shown in figure XIII-18 is larger for the small jet in the small drop inlet than for the large jet in the large drop inlet, the critical barrel wall thickness is also larger for a small drop inlet than for a large drop inlet. Thus, the increase in the critical barrel wall thickness with a decrease in the drop inlet size is satisfactorily explained by a consideration of the flow pattern.

Empirical equations for computing the entrance loss coefficients are first developed only for a 5D-high drop inlet and zero barrel slope and include only the effect of barrel wall thickness and drop inlet size on K_e. The effects of other parameters are evaluated later.

For a 5D-high drop inlet and zero barrel slope,

$$K_e = 0.9 + \frac{0.11}{\left(\frac{B}{D} - 1.0\right)^{3/2}} - 5.0\left(\frac{B}{D}\right)^{1/2}\left(\frac{t_p}{D}\right) \qquad \text{(XIII-10)}$$

for $t_p/D \leqq 0.06$ when $1.25 \leqq B/D < 1.5$[4]; and
for $t_p/D \leqq t_{p,cr}/D$ when $1.5 \leqq B/D \leqq 4.0$
(when $B/D > 4.0$, use $B/D = 4.0$)
and

$$K_e = 0.47 + \frac{0.03}{\left(\frac{B}{D} - 1.0\right)^{3}} \qquad \text{(XIII-11)}$$

for $t_p/D \geqq t_{p,cr}/D$ and $1.5 \leqq B/D \leqq 4.0$
(when $B/D > 4.0$, use $B/D = 4.0$).

An equation for the critical barrel thickness $t_{p,cr}/D$ can be obtained by simultaneously solving equations XIII-10 and XIII-11 to eliminate K_e and solving for t_p/D. Since equation XIII-11 is not valid for drop inlet sizes less than 1.5D, the critical barrel wall thicknesses are computed only for $B/D \geqq 1.5$. These critical wall thicknesses for drop inlets

1.5D, 2.0D, 2.5D, and 4.0D square
are 0.082D, 0.072D, 0.061D, and 0.045D.

As a point of interest, Harris'[5] experimental re-

[4] Although equation XIII-10 is valid over this range of drop inlet sizes, these sizes are not recommended—the recommendation being based on performance criteria.
[5] See footnote 3, p. 15.

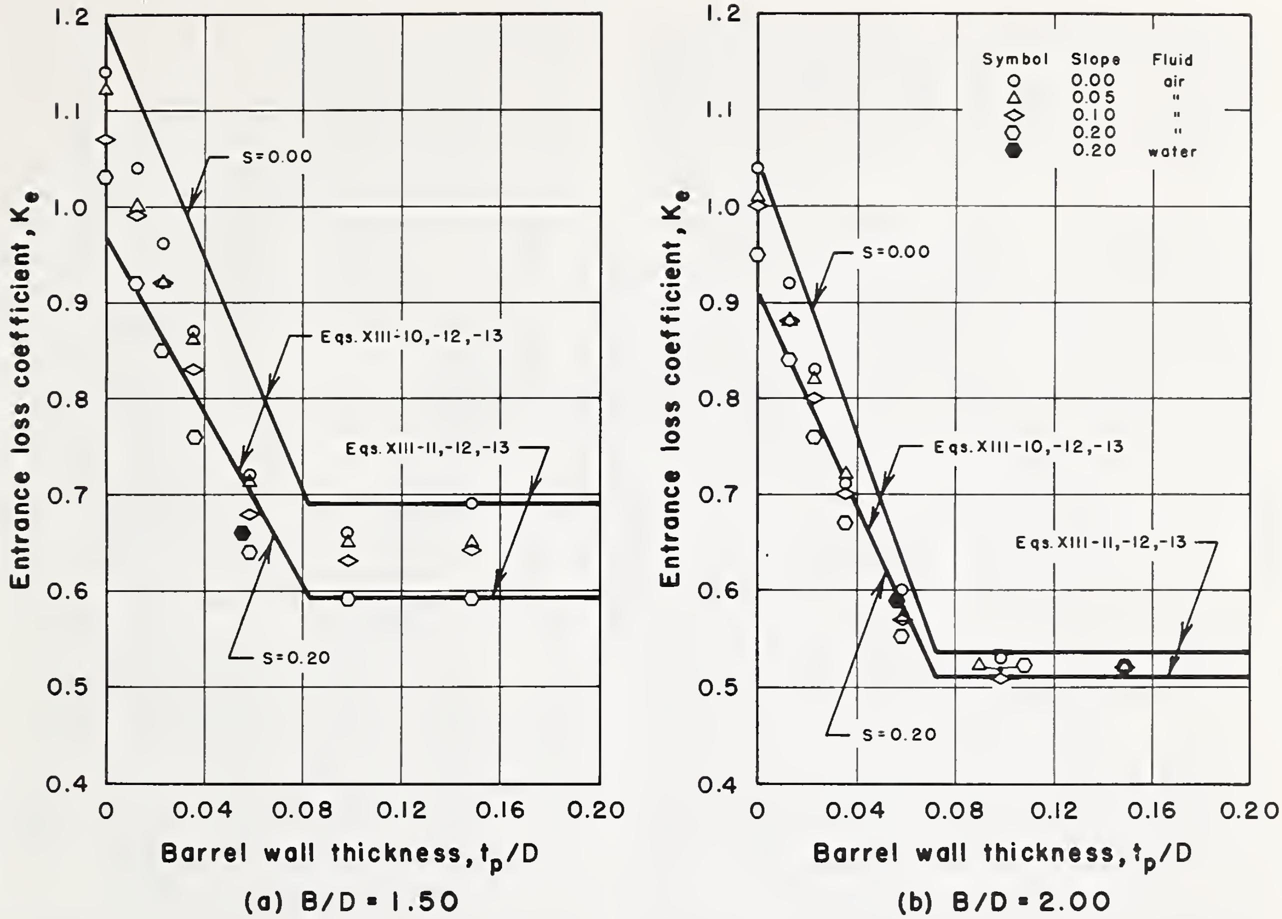


FIGURE XIII–14.—The effect of barrel wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_i/D = 0.50$.

sults indicate that the critical thickness is between 0.04D and 0.05D for a square reentrant pipe from an infinitely wide tank. The value of 0.045D for the largest drop inlet agrees well with Harris' value.

Effect of barrel slope.—The effect of the barrel slope on the entrance loss coefficient depends on the drop inlet size and barrel wall thickness. The data and curves in figure XIII–19 show that the entrance loss coefficient decreases linearly with an increase in the barrel slope. As shown by the change in the slope of the curves, the change in the entrance loss coefficient resulting from a change in the barrel slope decreases with an increase in both the drop inlet size and barrel wall thickness.

Because the entrance loss coefficients computed from equations XIII–10 and XIII–11 are valid only for zero barrel slope, for barrel slopes other than zero a barrel slope correction $\Delta K_{e,s}$ must be added to the coefficients computed using equations XIII–10 and XIII–11. This correction can be computed from the equation

$$\Delta K_{e,s} = -S\left[\left(\frac{0.42\,(B/D)^{2/3}}{\frac{B}{D} - 1.0}\right) - 7.5\left(\frac{t_p}{D}\right)\right] \qquad \text{(XIII–12)}$$

for $t_p/D \leqq 0.06$ and $1.25 \leqq B/D < 1.5$; and for $t_p/D \leqq t_{p,cr}/D$ and $1.5 \leqq B/D \leqq 4.0$ (when $t_p/D > t_{p,cr}/D$, use $t_p/D = t_{p,cr}/D$; and when $B/D > 4.0$, use $B/D = 4.0$).

Curves computed using equations XIII–10, XIII–11, and XIII–12 shown in figure XIII–19 agree well with the plotted data.

When the drop inlet is less than 1.5D square, thick barrels occupy a large portion of the drop inlet area and create choking flow conditions at the barrel entrance. Increasing the barrel slope moves the hood inlet crown closer to the downstream wall of the drop inlet, increases the flow area, reduces the choking, and improves the flow

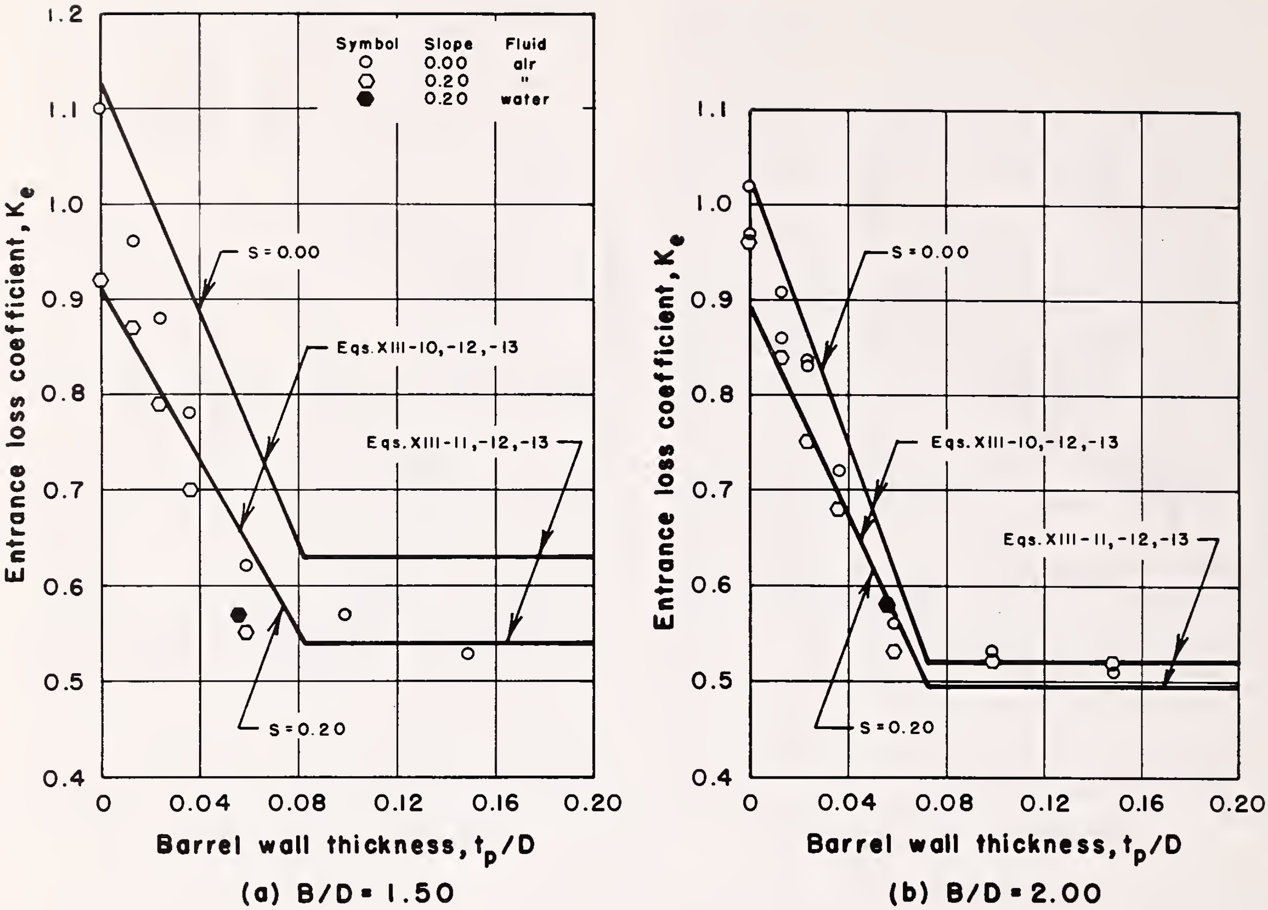


FIGURE XIII–15.—The effect of barrel wall thickness on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_1/D = 0.25$.

conditions at the barrel entrance, thus causing less energy loss. However, thick hoods when used with drop inlets less than 1.5D square show poor performance and are not recommended.

Effect of drop inlet size.—The size of the drop inlet has a significant effect on the entrance loss coefficient. Figure XIII–20, a typical plot, shows that the entrance loss coefficient decreases as the drop inlet size increases until it becomes approximately constant for sizes larger than about 3D. The higher entrance loss coefficient for small drop inlets is because the reentrant hood at the barrel entrance chokes the flow. Equations XIII–10 and XIII–11 can be used to compute the effect of drop inlet size on the entrance loss coefficient; the curves shown in figure XIII–20 are computed from these equations. The agreement of the data with the equation-computed curves is typical of that for all pertinent data.

An additional comment on the effect of drop inlet size on the entrance loss coefficient can be found in the following section.

Effect of drop inlet height.—The effect of the drop inlet height on the entrance loss coefficient varies with the drop inlet size. Figure XIII–21 shows that as the drop inlet height increases, the entrance loss coefficient increases until the height becomes 1.25D, decreases until the height becomes 3.25D, and remains constant for all drop inlets greater than 3.25D high. This variation of the entrance loss coefficient is due to the change in the flow pattern when the drop inlet height is changed. Figure XIII–22 shows these flow patterns for several drop inlet heights.

For drop inlets higher than 3.25D, figure XIII–22(a) shows that the boundary streamline separates from the outside edge of the drop inlet crest, enters the drop inlet, and attaches to the drop inlet inside wall. Beyond the point of attachment the streamlines become parallel to the drop

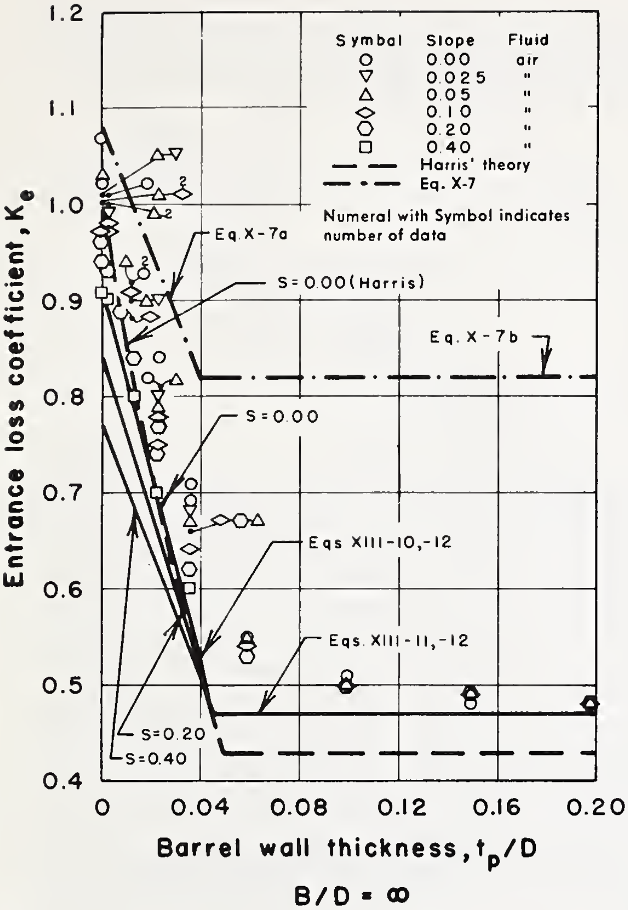


FIGURE XIII-16.—The effect of barrel wall thickness on the entrance loss coefficient for a hood inlet on a berm. $Z_1/D = 0.0$.

inlet walls, occupy the full area of the drop inlet, and then enter the hood inlet. This streamline pattern remains unchanged for all drop inlet heights greater than 3.25D, and, as a result, the entrance loss coefficient is constant as shown in figure XIII-21.

When the drop inlet height is less than 3.25D, the boundary streamline separates from the outside edge of the crest, and enters the drop inlet and then the hood without reattaching to the drop inlet wall as shown in figure XIII-22(b). This flow pattern reduces the effective flow area in the drop inlet and, as shown in figure XIII-21, increases the entrance loss coefficient as the drop inlet height decreases from 3.25D to 1.25D. For low drop inlets, the flow has easy access to the barrel entrance as shown in figure XIII-22(c).

Because the drop inlet height has less effect on the flow as its height decreases below 1.25D there is a decrease in the entrance loss coefficient as the drop inlet height decreases from 1.25D to 0.25D. This is shown in figure XIII-21.

Finally, as the drop inlet height reduces to zero, the flow patterns resulting from the drop inlets of different sizes must approach the flow pattern for the hood inlet without a drop inlet. Thus, the entrance loss coefficients must also approach a single value represented by the hood inlet. The dashed lines in figure XIII-21 also illustrate this point; the lines are dashed because no tests were

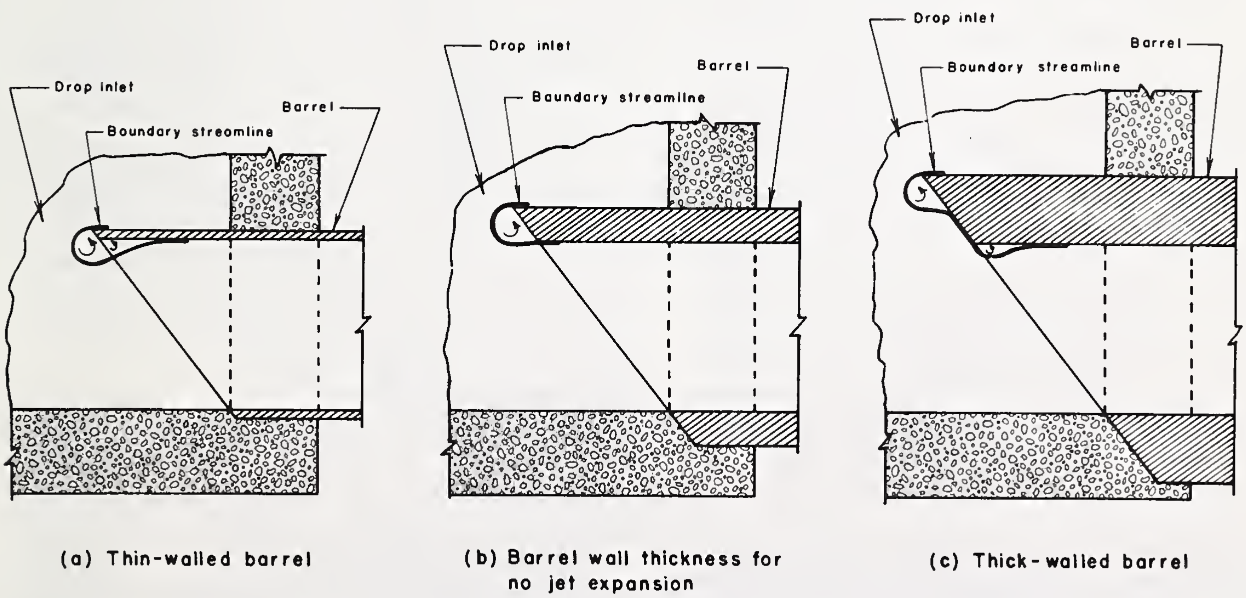
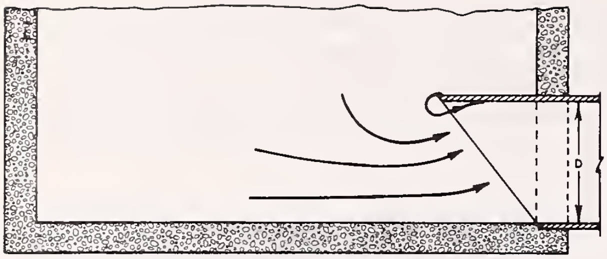
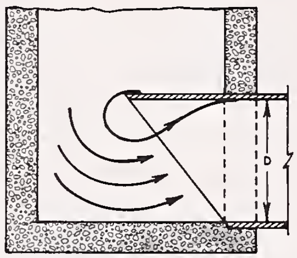


FIGURE XIII-17.—Boundary streamline at the barrel crown.



(a) Large drop inlet



(b) Small drop inlet

FIGURE XIII–18.—Flow pattern near the barrel entrance.

made for drop inlets between 0.0D and 0.25D high, and data are therefore not available to define the curve.

Figure XIII–21 shows that the change in the entrance loss coefficient attributed to a change in the drop inlet height from 1.25D to 3.25D—the difference between the peak and the constant values—is greatest for small-size drop inlets and decreases as the drop inlet size increases. This can be explained with the help of figures XIII–20 and XIII–22. The curves in figure XIII–20 show that a slight decreases in the drop inlet size causes a large increase in the entrance loss coefficient for small drop inlets whereas there is little change in the entrance loss coefficient for large drop inlets. This difference in the effect of drop inlet size can be explained with the aid of the streamline patterns in figure XIII–22 that show that the effective flow area in the drop inlet is a minimum when the drop inlet height is 1.25D.

To summarize this section: The curves of figure XIII–21 and the sketches of figure XIII–22 illustrate that the effect of the flow on the entrance loss coefficient is greatest when the drop inlet is 1.25D square. They also show that the peak value of the coefficient is reduced as the drop inlet size is increased.

Corrections for the effect of drop inlet height must be applied to equations XIII–10 and XIII–11 because they are valid only for a 5D-high drop inlet. For drop inlets other than 5D high, the correction $\Delta K_{e,z}$ to be added to the coefficients computed from equations XIII–10 and XIII–11 is:
for $0.25 \leqq Z_l/D \leqq 1.25$,

$$\Delta K_{e,z} = \frac{0.06}{\left(\frac{B}{D} - 1.0\right)^2} \left\{\frac{Z_l}{D} - 1.25 + 1.33\left(\frac{B}{D} - 1.0\right)\right\} \quad \text{(XIII–13)}$$

for $1.25 \leqq Z_l/D \leqq 3.25$,

$$\Delta K_{e,z} = \frac{0.04\left(3.25 - \frac{Z_l}{D}\right)}{\left(\frac{B}{D} - 1.0\right)} \quad \text{(XIII–14)}$$

and for $Z_l/D \geqq 3.25$,

$$\Delta K_{e,z} = 0 \quad \text{(XIII–15)}$$

Because no data are available for drop inlets between 0.0D and 0.25D high, a different method must be used to estimate the entrance loss coefficient for those drop inlets. The entrance loss coefficient for a 0.0D-high drop inlet (a hood inlet on a berm) is computed from equations XIII–10 through XIII–12 using $B/D = 4$ or from equations X–7a and X–7b. For 0.25D-high drop inlets the entrance loss coefficient is computed from equations XIII–10, XIII–11 and XIII–13. For drop inlet heights between 0.0D and 0.25D, the authors suggest that the entrance loss coefficients be computed by linear interpolation between the values for the 0.0D-high and 0.25D-high drop inlets.

Precision of the equations.—The entrance loss coefficients computed from equations XIII–10 through XIII–15 were compared with those obtained from the test data. The differences between the computed and observed values indicate the precision of the equations. A positive difference indicates that the equation value is higher than the observed value. These differences are divided by the observed values to obtain the percentage differences. The entrance loss coefficients K_e observed and computed, and the actual (computed — observed) and percentage differences are presented in table XIII–5 (appendix) for the air tests and in table XIII–7 (appendix) for the water tests. Computed values are given for only recommended drop inlets.

Table XIII–2 gives a detailed precision analysis of the equations using air data from table XIII–5 (appendix). The average differences are computed by averaging the absolute sum of the differences between the computed and observed values. The data summarized in table XIII–2 are broken down to give the maximum actual and

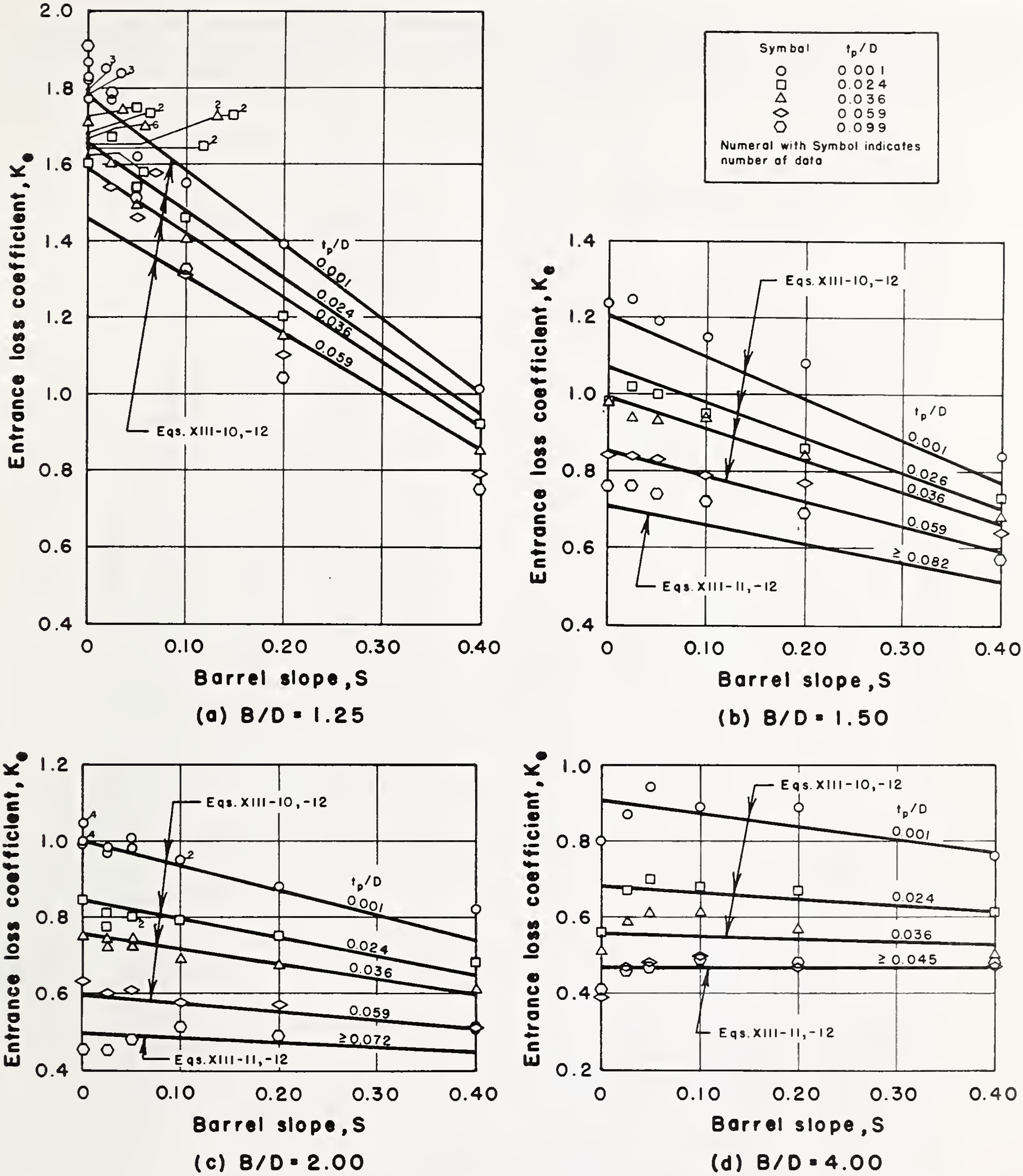


FIGURE XIII-19.—The effect of barrel slope on the entrance loss coefficient for square drop inlet—reentrant hood. $Z_l/D = 5.00$.

percentage differences between the computed and observed values for each drop inlet size. The percent of computed values that agree with the test data within the specified limits for each drop inlet size are also given in table XIII–2. These values indicate the quantitative and qualitative

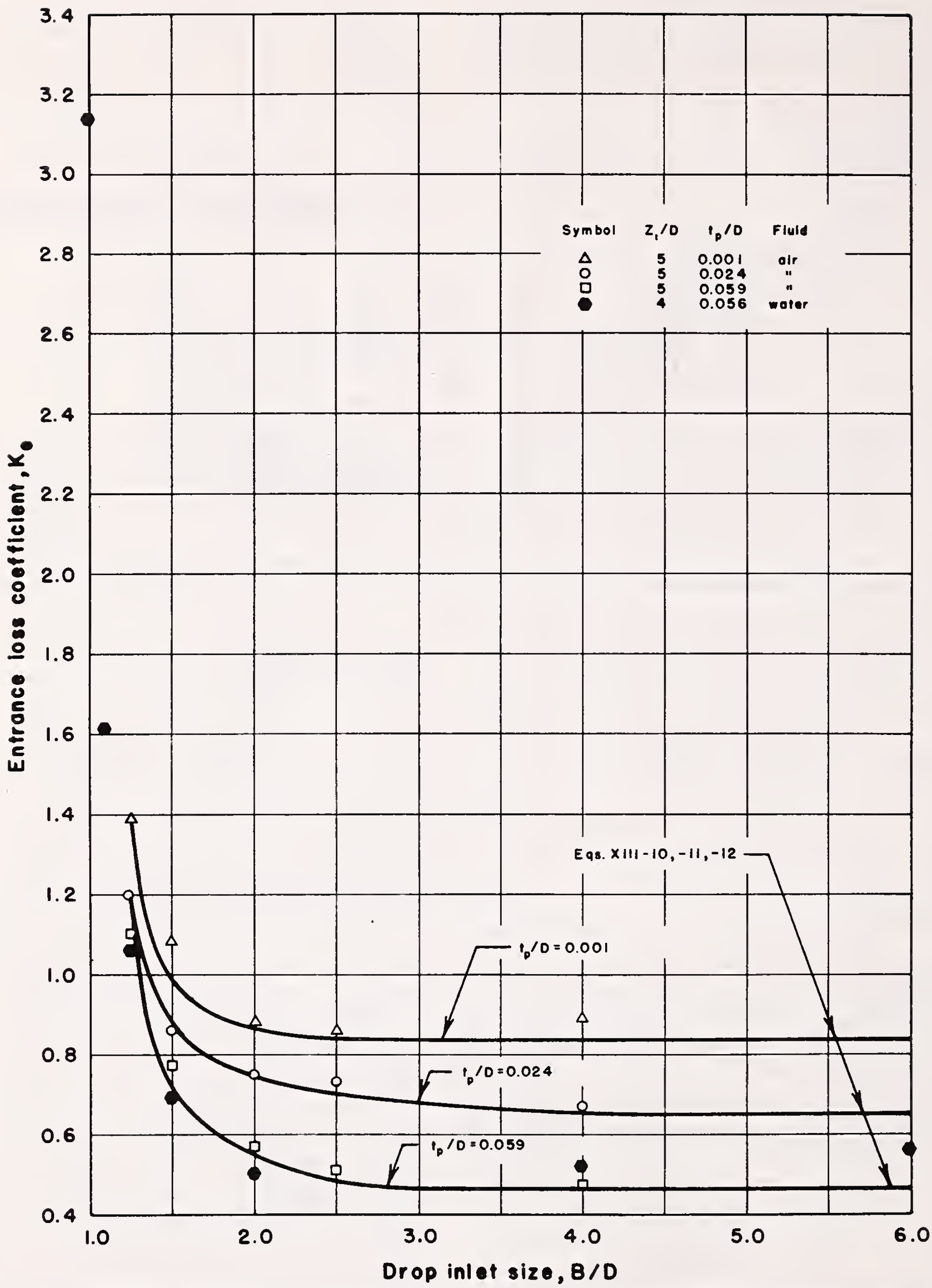


FIGURE XIII-20.—The effect of drop inlet size on the entrance loss coefficient for square drop inlet—reentrant hood. S = 0.20.

representation of the equations' precision.

The precision of the equations was also analyzed using 24 water tests from table XIII-7 (appendix). The average difference without regard to sign is 12 percent or 0.07 actual. The maximum positive and negative differences are

+14 percent (series W-111) or +0.07 actual (series W-111) and −23 percent (series W-154) or −0.14 actual (series W-154).

In addition to this numerical evaluation of the precision of the equations, the agreement of the equations with the test data is graphically pre-

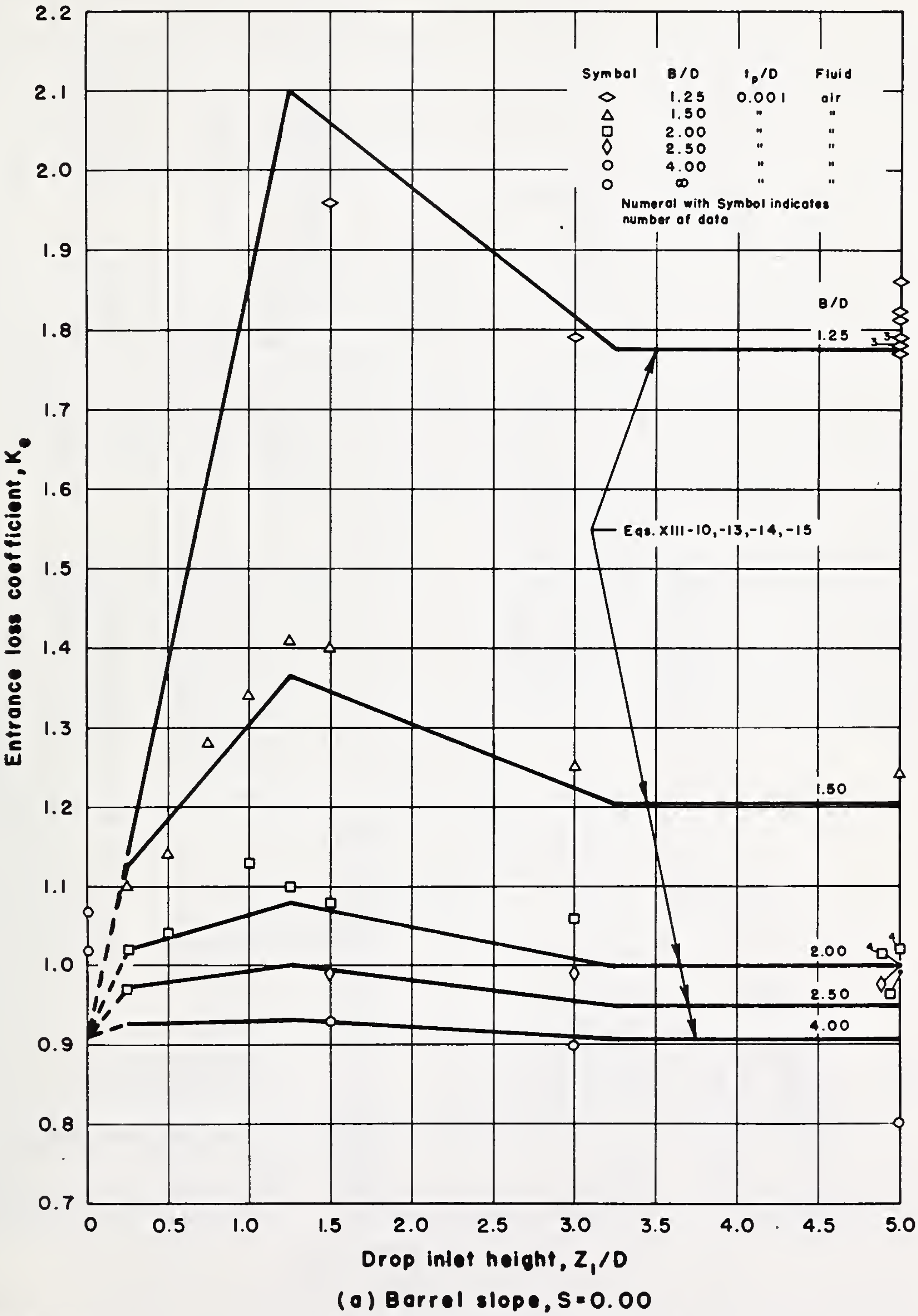


FIGURE XIII-21.—The effect of drop inlet height on the entrance loss coefficient for square drop inlet—reentrant hood.

sented in figures XIII–8 through XIII–16, except for the water data for $Z_l/D = 2$ and 4 which were not plotted.

(Note that the graphical comparisons are also for drop inlets that do not meet the performance-based recommended sizes.)

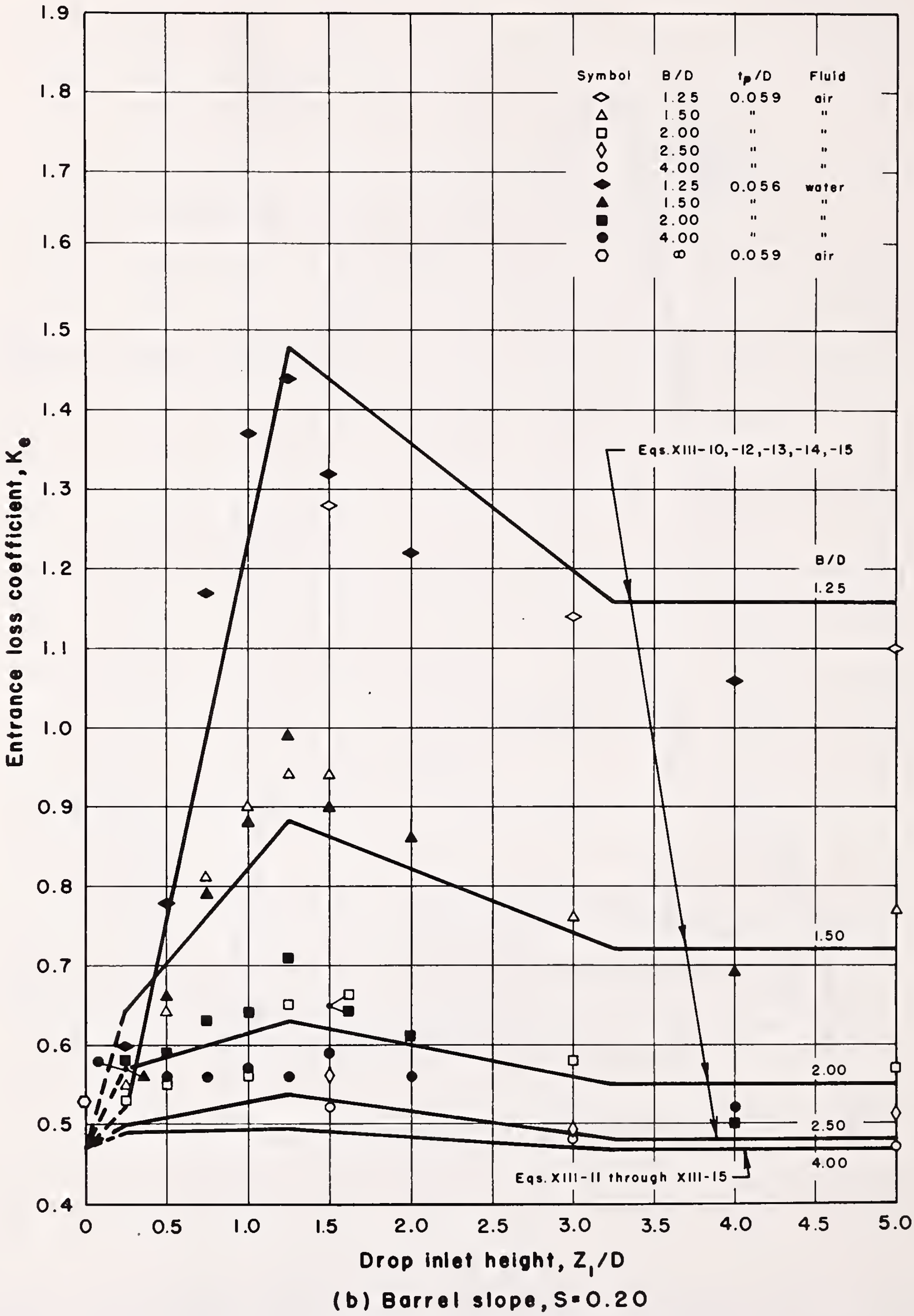


FIGURE XIII–21.—Continued.

Circular drop inlet—reentrant hood

For the circular drop inlet with a reentrant hood barrel entrance the variables tested were the discharge, barrel wall thickness, barrel slope, drop inlet size, and drop inlet height. The magnitudes and ranges of the variables are presented in the Experimental Program section. A limited number of tests, 114 series (74 air and 40 water), were conducted with different combinations of these variables. Summaries of the results are presented in table XIII–6 (appendix) for the air tests and table XIII–8 (appendix) for the water tests.

The entrance loss coefficients determined from these circular drop inlet tests exhibit the same trends as those found in the study of the square drop inlet with a reentrant hood. Therefore, the square drop inlet entrance loss coefficient equations XIII–10 through XIII–15 can be used, after adjusting the circular drop inlet size to an equivalent square drop inlet size, to compute the entrance loss coefficients for circular drop inlets. A discussion follows on the validity, use, and precision of these equations when used to determine the entrance loss coefficients for the circular drop inlets.

Effect of discharge.—Five discharges with Reynolds numbers ranging from 1.2×10^5 to 2.5×10^5 were used for each series. The entrance loss coefficients were computed for each discharge. As for the square drop inlet with a reentrant hood, these results indicate that the entrance loss coefficient is independent of the Reynolds number. Therefore, average values of the entrance loss coefficients are used in the analyses.

Effect of barrel wall thickness.—Figure XIII–23 shows that the entrance loss coefficient decreases linearly as the barrel wall thickness increases for thin barrels. This is the same trend and the magnitudes are the same as observed for the square drop inlet tests. Therefore, when the barrel wall is thin, the square drop inlet test results represented by equation XIII–10 can be used to determine the entrance loss coefficient for circular drop inlets. Curves representing the appropriate equations have been plotted in figure XIII–23. The agreement between the computed and experimental results is good for drop inlets equal to or greater than 2D in diameter, the previously determined minimum size for satisfactory performance of the circular drop inlet.

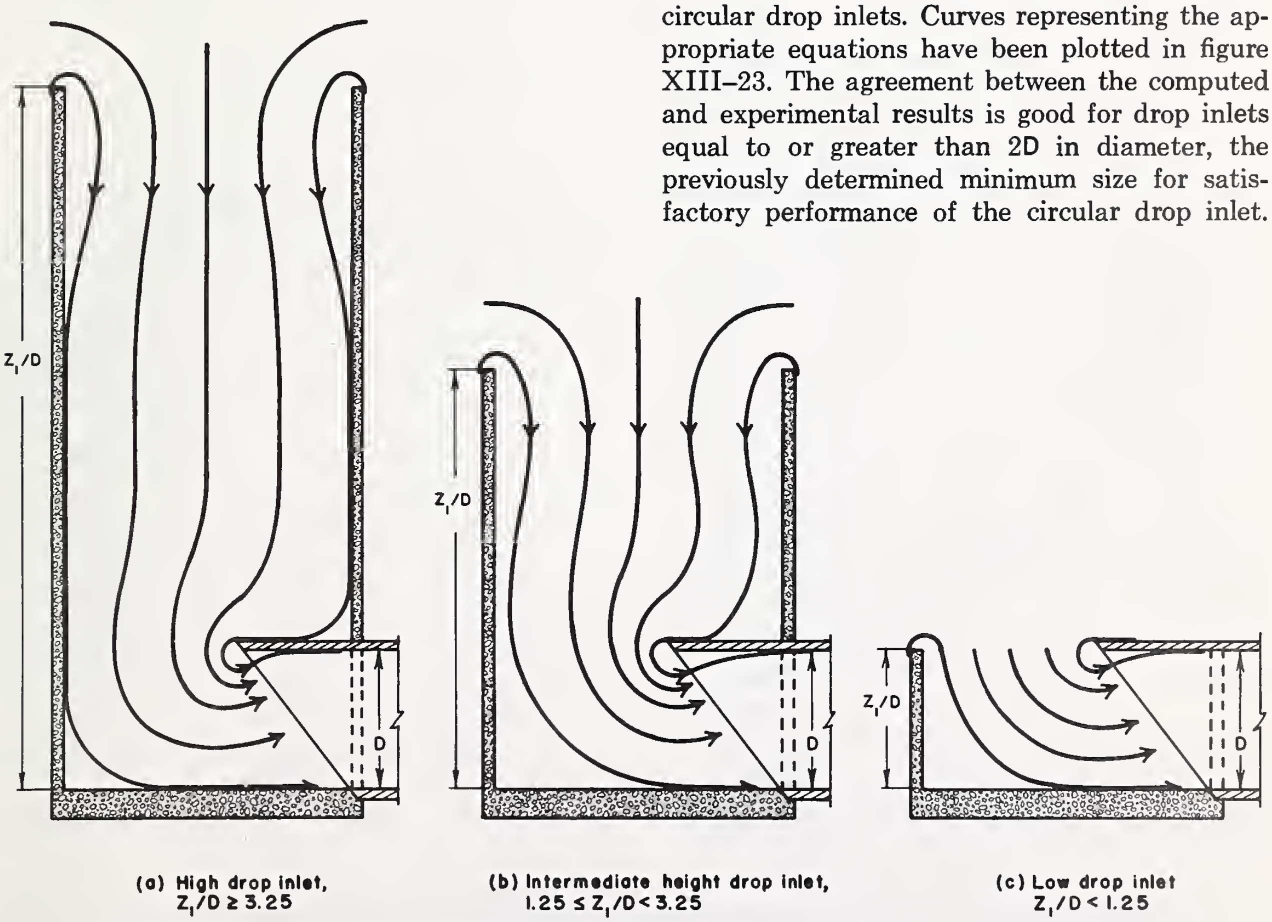
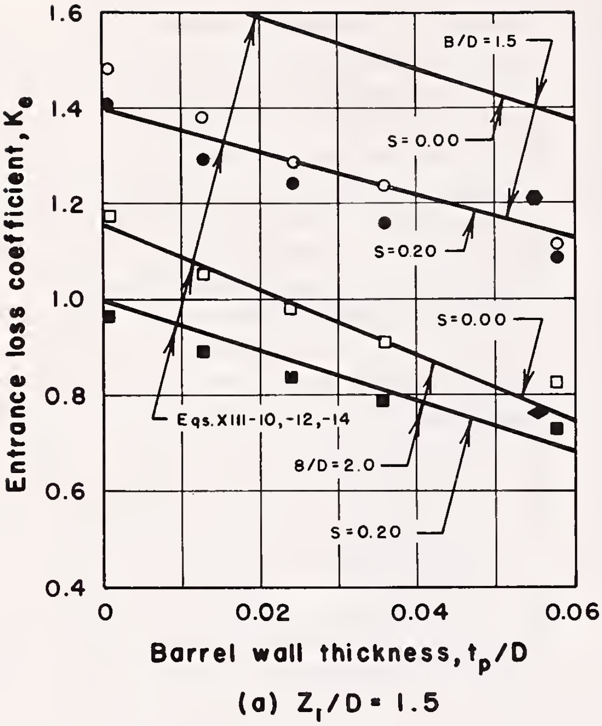
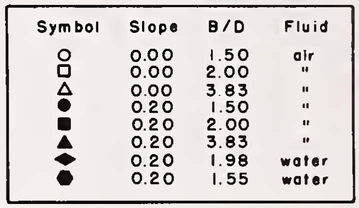


FIGURE XIII–22.—The effect of drop inlet height on the flow pattern near the barrel entrance.

For thick barrels only two tests were conducted —barrel slopes of 0 and 20 percent on a drop inlet 3.83D in diameter and 2D high. Figure XIII–23(b) shows these experimental results and the curve computed from equations XIII–11, XIII–12, and XIII–14. The agreement is good, indicating that equations, which are developed from square drop inlet tests results, can be used to compute the entrance loss coefficient for adequate size circular drop inlets with thick hood barrel entrances.





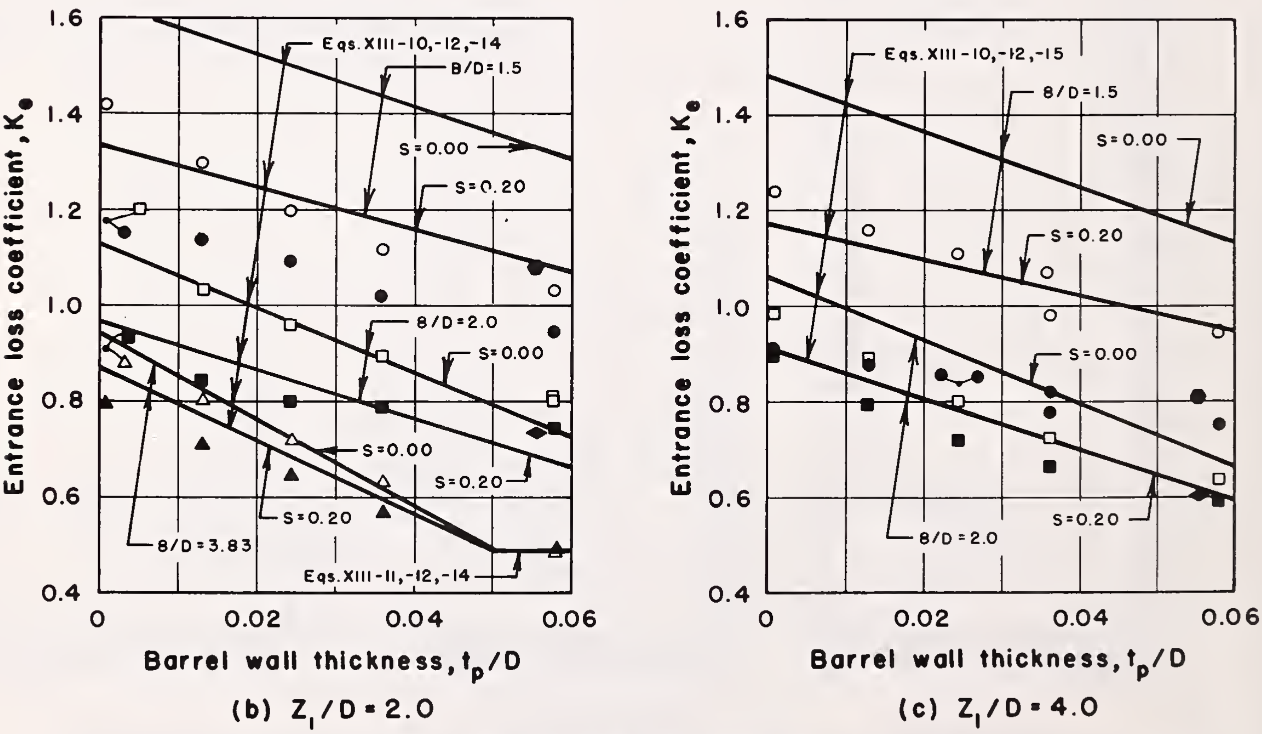


FIGURE XIII–23.—The effect of barrel wall thickness on the entrance loss coefficient for circular drop inlet—reentrant hood.

TABLE XIII–2.—*Precision of the equations for computing the entrance loss coefficients for square drop inlets with reentrant hood barrel entrances*

Description	Drop inlet size, B/D					Total
	1.50	2.00	2.50	4.00	∞	
Number of series checked:	172	191	96	151	66	676
Average differences:						
Actual value	0.04	0.02	0.02	0.03	0.10	0.03
Percent	4.7	3.1	3.6	4.2	12.0	4.7
Maximum differences:						
Positive:						
Actual value	0.14	0.06	0.15	0.16	-----	0.16
Percent	20	11	25	24	-----	25
Negative:						
Actual value	0.11	0.08	0.05	0.09	0.16	0.16
Percent	16	12	9	13	21	21
Percent of computed values that agree with the data within:						
Actual value:						
±0.05	72	97	97	90	18	81
±0.075	86	99	98	93	23	87
Percent:						
±5	63	80	74	70	12	66
±10	92	97	97	91	18	87

Effect of barrel slope.—Because only barrel slopes of 0 and 20 percent were tested, the data are limited. However, the available data presented in figure XIII–23 show that the entrance loss coefficient decreases with an increase in the barrel slope as expected and as observed for the square drop inlet. In addition, the agreement of the curves with the data shows that the change in the entrance loss coefficient attributed to a change in the barrel slope for circular drop inlets can be computed from equation XIII–12 developed from the square drop inlet data.

Effect of drop inlet size.—The effect of the drop inlet size on the entrance loss coefficient for the circular drop inlet is similar to that observed for the square drop inlet.[6] The data presented in figure XIII–24 show a direct comparison of results between the square (open data points) and circular (solid data points) drop inlet tests. (Similar symbols represent identical drop inlet heights.) Curves giving the entrance loss coefficients computed from equations XIII–10 through XIII–15 are also shown in figure XIII–24.

The entrance loss coefficient decreases as the drop inlet size increases. The rate of decrease is rapid for small drop inlets and decreases as the drop inlet size increases until, for large drop inlets, the coefficient becomes approximately constant.

Effect of drop inlet height.—Not enough combinations of the drop inlet size and height were tested to determine the effect of drop inlet size and height on the entrance loss coefficient. However, the test results obtained for the circular drop inlet are compared with the experimental and equation results obtained for the square drop inlet. Figure XIII–24 shows this comparison. The good agreement of the plotted data with the curves representing the equations shows that the equations developed for square drop inlet satisfactorily represent the circular drop inlet data. The vertical spread of the data shown in figure XIII–24 represents the effect of the drop inlet height on the entrance loss coefficient.

Comparison with the square drop inlet.—The drop inlet size is defined as the diameter for a circular drop inlet and as the side length for a square drop inlet. Because the area of a circular drop inlet is less than that of a square drop inlet of the same defined size, a direct comparison between the circular and square drop inlet results on the basis of a defined size will include the effect of the drop inlet area on the entrance loss coefficient. This area effect is eliminated by substituting for the circular drop inlet size a size of square drop inlet with the same area as the circular drop inlet. By equating the areas, the ratio between the side length of the equivalent square drop inlet and the diameter of the circular drop inlet becomes 0.886. Therefore, for this comparison, the circular drop inlet size is multiplied by 0.886 to obtain an equivalent square drop inlet size.

Figures XIII–24 compares the entrance loss coefficients for square (open data points) and circular (solid data points) drop inlets, the water and air test results (different symbols), and the equations and the experimental results. For this comparison the barrel slope is 20 percent, and the barrel wall thicknesses are 0.056D for the

[6] The circular drop inlet sizes were adjusted to make possible a direct comparison of their results with those of the square drop inlets. This size adjustment is explained later in the section Comparison with the square drop inlet.

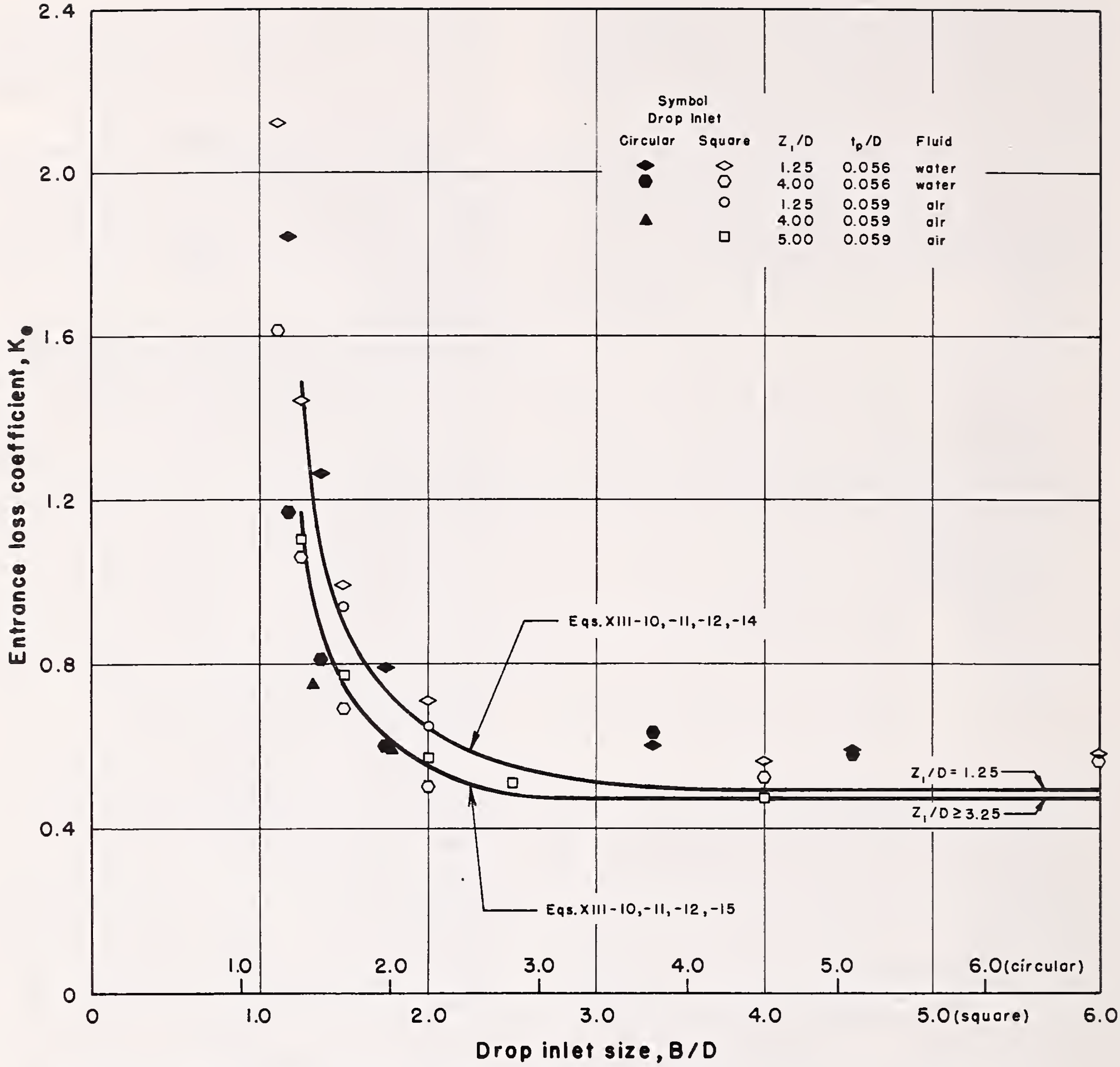


FIGURE XIII–24.—Comparison of entrance loss coefficients for the square and circular drop inlets. $S = 0.0$.

water tests and 0.059D for the air tests. The agreement between the results in figure XIII–24 indicates that for drop inlets having equal areas the effect of shape of the drop inlet on the entrance loss coefficient is insignificant.

The curves drawn in figure XIII–24 show the entrance loss coefficients computed from equations XIII–10 through XIII-15 for square drop inlets 1.25D high and equal to or greater than 3.25D high. These two drop inlet heights are used because the entrance loss coefficient is maximum for the 1.25D-high drop inlet and is constant for 3.25D and higher drop inlets. Figure XIII–24 also shows that the experimental results of both square and circular drop inlets from both the air and water tests agree well with those computed from the equations. Therefore, equations XIII–10 through XIII–15 developed from the square drop inlet data can be used to determine the entrance loss coefficients for circular drop inlets after making the necessary diameter adjustment; in equations XIII–10 through XIII–14, B for circular

drop inlets must be multiplied by 0.886 to obtain an equivalent B for the square drop inlets for which the equations were developed.

Precision of the equation.—The entrance loss coefficients for circular drop inlets were computed from equations XIII–10 through XIII–15 using an equivalent-size square drop inlet having the same area as that of a circular drop inlet. The actual and percentage differences between the computed and observed coefficients were determined. The differences and the observed and computed entrance loss coefficients K_e appear in table XIII–6 (appendix) for the the air tests and in table XIII–8 (appendix) for the water tests.

The average difference without regard to sign for the 41 valid air tests is 5 percent or 0.04 actual. The maximum positive and negative differences are +14 percent (series A-1527) or +0.10 actual (series A-1526 and A-1527) and −10 percent (series A-1553) or −0.07 actual (series A-1548 and A-1553).

The average difference without regard to sign for the 16 valid water tests is 16 percent or 0.10 actual. The maximum positive and negative differences are +3 percent (series W-163) or +0.02 actual (series W-163) and −25 percent (series W-167) or −0.16 actual (series W-167).

In addition to this numerical evaluation of the precision of the equations, the agreement of the equations with the test data is graphically presented in figure XIII–23 for $Z_l/D = 1.5$, 2 and 4 only. The water data for $0.25 < Z_l/D < 1.25$ were not plotted.

Square drop inlet—flush entrance hood

The square drop inlet with a flush entrance hood shown in figure XIII–2A produces smoother flow conditions at the barrel entrance than does the reentrant hood. Only 40 series of tests were made. The variables tested were the discharge, drop inlet size and drop inlet height. Only one barrel slope, 20 percent, was used. Because the flush entrance hood acts as a thick barrel, barrel wall thickness is eliminated as a variable. The experiments on the square drop inlet with a flush hood entrance were conducted only with the water apparatus. The results are summarized in table XIII–9 (appendix).

Effect of drop inlet size.—Figure XIII–25 shows the effect of the drop inlet size on the entrance loss coefficients for eight drop inlet heights ranging from 0.25D to 4D. Because the flush hood entrance is equivalent to a thick reentrant hood entrance, the flush hood entrance results will be compared with those of the reentrant hood 0.099D thick.

Comparison with the reentrant hood.—The entrance loss coefficients for the square inlets with reentrant and with flush entrance hoods are compared in figure XIII–25. The data indicate that the variation of the entrance loss coefficient with drop inlet size is the same for a flush hood barrel entrance as was previously found for a reentrant hood barrel entrance. Since the flush entrance hood acts as a thick barrel, the curves computed using equations XIII–11 through XIII–15, which represent thick hoods, are plotted in figure XIII–25.

For the small drop inlets, $B = 1.25D$, the data (open points) for the flush entrance hood shown in figure XIII–25 fall below the data (solid points) for the reentrant hood, indicating that the flush hood entrance causes less energy loss than the reentrant hood entrance. This is because the reentrant hood projects into the drop inlet and reduces the effective flow area in the drop inlet, causing choked flow conditions near the barrel entrance.

Because the data are limited and their scatter is large for these small drop inlets, equations for computing the entrance loss coefficients cannot be developed and extrapolation of equations XIII–11 through XIII–15 below $B = 1.5D$ gives unrealistically high values that are not supported by the available test data. However, the data in figure XIII–25 can be used to estimate the entrance loss coefficients for square drop inlet sizes $1.25D \leqq B < 1.5D$ with a flush hood entrance. (Square drop inlets with a flush barrel entrance smaller than 1.25D are not recommended on the basis of performance.)

For the drop inlets where $B \geqq 1.5D$, the reentrant and flush entrance hoods cause, within the limits of precision of the experiments, nearly the same energy loss. This is because the reduction in the effective flow area in the drop inlet caused by the reentrant hood is insignificant in comparison with the actual drop inlet area. Also the choking flow conditions caused by the presence of the reentrant hood disappear and both the flush entrance and reentrant hoods cause nearly the same energy loss. Therefore, as figure XIII–25 shows by the approximate agreement of the data with the curves representing the equations,

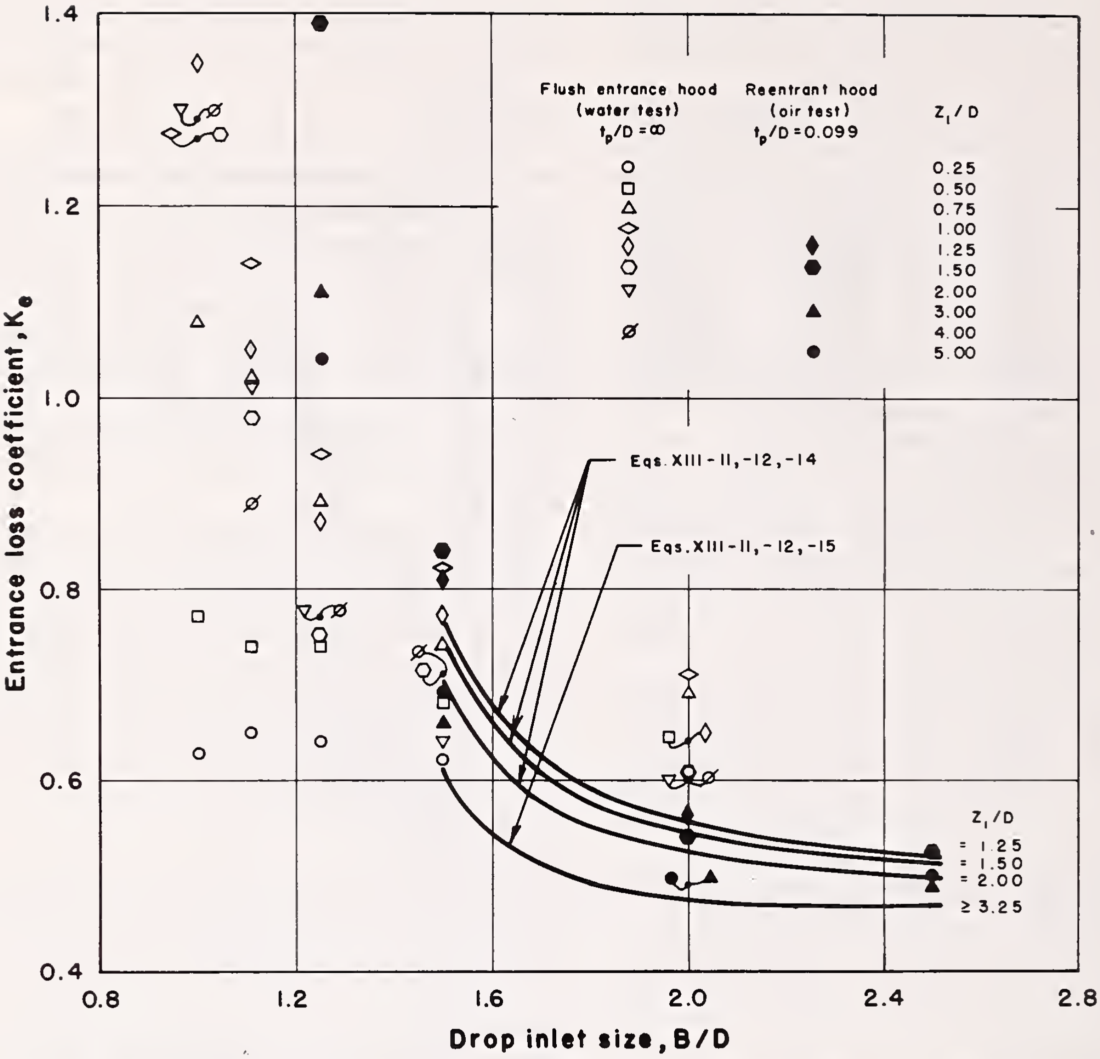


FIGURE XIII-25.—The effect of drop inlet size on the entrance loss coefficient for square drop inlet—flush entrance hood. S = 0.20.

equations XIII–11 through XIII–15 can be used to compute the entrance loss coefficient for square drop inlets with a flush entrance hood of size $B \geqq 1.5D$.

Precision of the equations.—The entrance loss coefficients for square drop inlets with a flush hood barrel entrance were computed from equations XIII–11 through XIII–15. The differences between the computed and observed values are calculated. The entrance loss coefficients K_e observed and computed, and the actual and percentage differences are presented in table XIII–9 (appendix).

The average difference without regard to sign for the 16 valid tests is 14 percent or 0.09 actual. The maximum positive and negative differences are +6 (series W-226) and −24 (series W-238) percent. Because only limited data are available, the quantitative analysis that determines the precision of the equations is also limited.

In addition to this numerical evaluation of the precision of the equations, the agreement of the equations with the test data is graphically presented in figure XIII–25. Because no air data were obtained for the flush hood entrance, the evaluation in figure XIII–25 is for water data only.

Pressure coefficients

A hood inlet at the bottom of a drop inlet causes a local reduction in pressure at the barrel entrance. When these pressures become less than

the vapor pressure, cavitation will occur. This cavitation may damage the barrel. To permit determination of the prototype pressures and the cavitation potential within the barrel entrance, the invert and crown pressures at a distance D/2 inside the barrel were measured during the laboratory tests.

The actual pressure in the prototype barrel entrance can be obtained from the pressure coefficient equations presented in the next column. The pressure coefficients h_n/h_{vp} developed from the laboratory tests when multiplied by the velocity head in the barrel h_{vp} represent the local pressure deviation h_n from the friction gradeline. Details of computing the actual pressures are given in Part I, page 13.

The results of the tests to determine pressure coefficients near the barrel entrance will be presented for square and for circular drop inlets with reentrant hoods and square drop inlets with a flush entrance hood. The averages of the pressure coefficients h_n/h_{vp} obtained from several test runs are recorded in tables XIII–5 through XIII–9 (appendix).

Square drop inlet—reentrant hood

The pressures near the barrel entrance for a square drop inlet with a reentrant hood were measured during both air and water tests. The pressure coefficients are listed in table XIII–5 (appendix) for the air tests and in table XIII–7 (appendix) for the water tests.

In the following sections the pressure coefficients on the invert and on the crown in the barrel entrance are presented, equations for computing the pressure coefficients in the barrel entrance are developed, and the precision of these equations is discussed.

Barrel entrance pressure coefficients.—The pressures near the barrel entrance were measured at three locations: on the crown D/2 from the entrance invert, and on the invert D/8 and D/2 from the entrance. Figure XIII–26 shows a typical plot of the pressure coefficients at these three locations.

A comparison of the invert pressure coefficients shown in figure XIII–26 shows that the lowest pressure coefficient occurs at D/2 from the barrel entrance. Since the pressure on the invert D/8 from the entrance was measured only to determine the location of the minimum pressure, this pressure was measured only for a few air test series.

The pressure coefficients at the crown and the invert D/2 from the barrel entrance were used for the analyses presented here. They are presented in tables XIII–5 through XIII–9 (appendix).

The pressure coefficients at the barrel *crown* D/2 from the barrel entrance invert for square drop inlets with hood barrel entrances are given by equations XIII–16 and XIII–17.

For $Z_i/D=0$ ($B/D=\infty$, a hood inlet on a berm),

$$\left(\frac{h_n}{h_{vp}}\right)_c = -0.03 + 0.26\sqrt{S}\left\langle 1 - \frac{t_p/D}{0.06}\right\rangle \quad \text{(XIII–16)}$$

where the quantity inside the pointed brackets $\langle\ \rangle$ is zero for negative values,
and for $0 < Z_i/D \leqq 5.0$ and $1.5 \leqq B/D \leqq 4.0$,

$$\left(\frac{h_n}{h_{vp}}\right)_c = -0.03 \quad \text{(XIII–17a)}$$

except that for $t_p/D < 0.06$ (thin-walled barrels) and $B/D = 1.5$,

$$\left(\frac{h_n}{h_{vp}}\right)_c = -0.10 \quad \text{(XIII–17b)}$$

The pressure coefficients on the *invert* D/2 from the barrel entrance for square drop inlets with reentrant hood barrel entrances are given by equations XIII–18, XIII–19, and XIII–20.

For $Z_i/D=0$ ($B/D=\infty$, a hood inlet on a berm),

$$\left(\frac{h_n}{h_{vp}}\right)_i = -0.17 - \left\langle 0.25 - 3.5\frac{t_p}{D}\right\rangle \quad \text{(XIII–18)}$$

for $0 < Z_i/D \leqq 1.25$,

$$\left(\frac{h_n}{h_{vp}}\right)_i = (\text{eq. XIII–18}) + 0.8\left(\frac{Z_i}{D}\right)\Big\{(\text{eq. XIII–20}) - (\text{eq. XIII–18})\Big\} \quad \text{(XIII–19)}$$

and for $Z_i/D \geqq 1.25$,
and when $1.25 \leqq B/D \leqq 4.0$,

$$\left(\frac{h_n}{h_{vp}}\right)_i = -\left\{\frac{1.5\langle 0.06 - t_p/D\rangle}{\left(\frac{B}{D} - 1.0\right)^{2/3}}\right\} - \left\langle 0.4 - 0.133\left|\frac{B}{D} - 2.0\right|\right\rangle S^{3/4} - \left\{0.07\left(\frac{B}{D} - 1.0\right)^{6/4} + \frac{1}{(B/D)^3}\right\} \quad \text{(XIII–20)}$$

where the vertical lines $|\ |$ indicate the absolute value of the quantity inside the bracket. The terms in the equations represent the effects of the barrel wall thickness, the barrel slope, and the drop inlet size, respectively, on the pressure coefficients for various size square drop inlets with reentrant barrel entrances. These effects and the terms in the equation are discussed in the following paragraphs.

Effect of barrel wall thickness.—When there

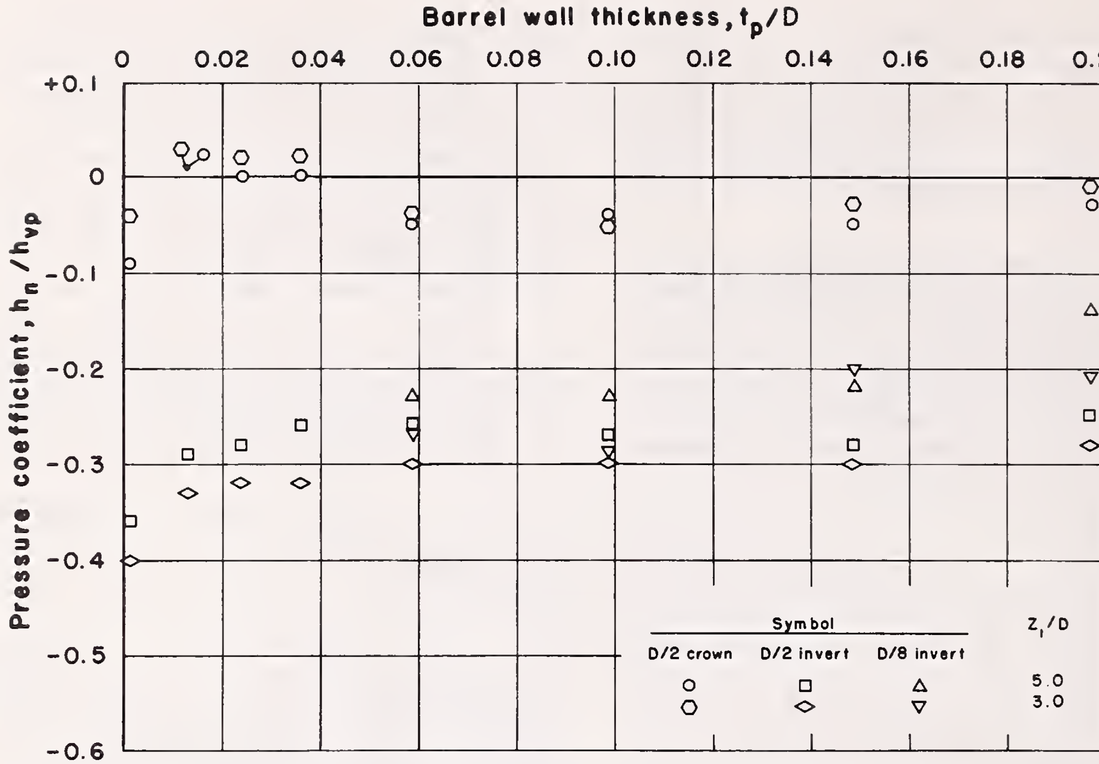


FIGURE XIII-26.—Comparison of pressure coefficients in the barrel entrance at crown and invert for square drop inlet—reentrant hood. $B/D = 2.5$, $S = 0.20$.

is no drop inlet, the effect of barrel wall thickness on the pressure coefficient is given by equations XIII-16 and XIII-18. The barrel wall thickness affects the pressure coefficients only for thin-walled barrels—$t_p < 0.06D$ for the crown equation XIII-16 and $t_p < 0.0714D$ for the invert equation XIII-18.

When there is a drop inlet, there is no effect of the barrel wall thickness on the crown pressure coefficient, except for thin-walled barrels, $t_p < 0.06D$, and the smallest satisfactory drop inlet, $B/D = 1.5$. These crown pressure coefficients are given by equations XIII-17.

The effect of the barrel wall thickness on the invert pressure coefficients for four drop inlet sizes is shown typically in figure XIII-27. The pressure coefficient increases linearly as the barrel wall thickness increases for $t_p < 0.06D$ and remains constant for $t_p \geqq 0.06D$, except for $B/D = \infty$ where the pressure coefficient remains constant for $t_p \geqq 0.0714D$. The first term in equation XIII-20 represents this effect.

For barrel wall thicknesses less than 0.06D, the term inside the pointed brackets is positive, and its value decreases as the wall thickness increases. For barrel wall thicknesses greater than 0.06D, the term inside the pointed brackets becomes negative but should be considered equal to zero. The first term in equation XIII-20 is therefore zero when $t_p/D \geqq 0.06$ indicating that the pressure coefficient is constant for $t_p \geqq 0.06D$.

Effect of barrel slope.—The barrel slope has no effect on the crown pressure coefficient for thick-walled barrels where $t_p \geqq 0.06D$. For thin-walled barrels, $t_p < 0.06D$, the barrel slope does affect the crown pressure coefficient. This effect is given by the second term of equation XIII-16.

The effect of barrel slope on the invert pressure coefficient depends on the drop inlet size as indicated by the second term in equation XIII-20. In this term, the absolute value of $\left|\frac{B}{D} - 2.0\right|$ is used. The data in figure XIII-28 show that as the drop inlet size increases, the effect of the barrel slope on the pressure coefficient increases until the barrel slope effect reaches a miximum for drop inlets 2D square; then the barrel slope effect decreases until it becomes zero for an in-

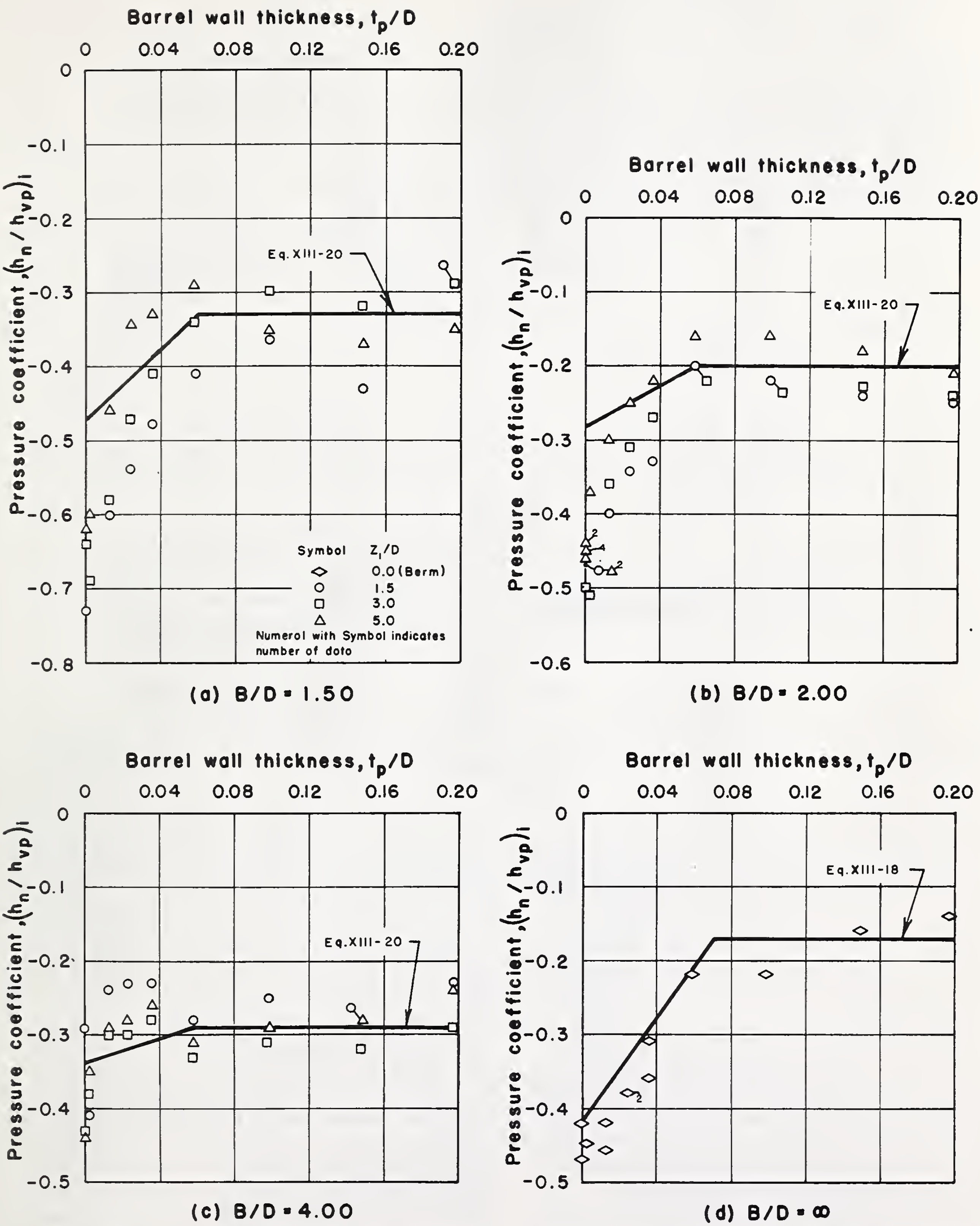


FIGURE XIII-27.—The effect of barrel wall thickness on the invert pressure coefficient for square drop inlet—reentrant hood. S = 0.0.

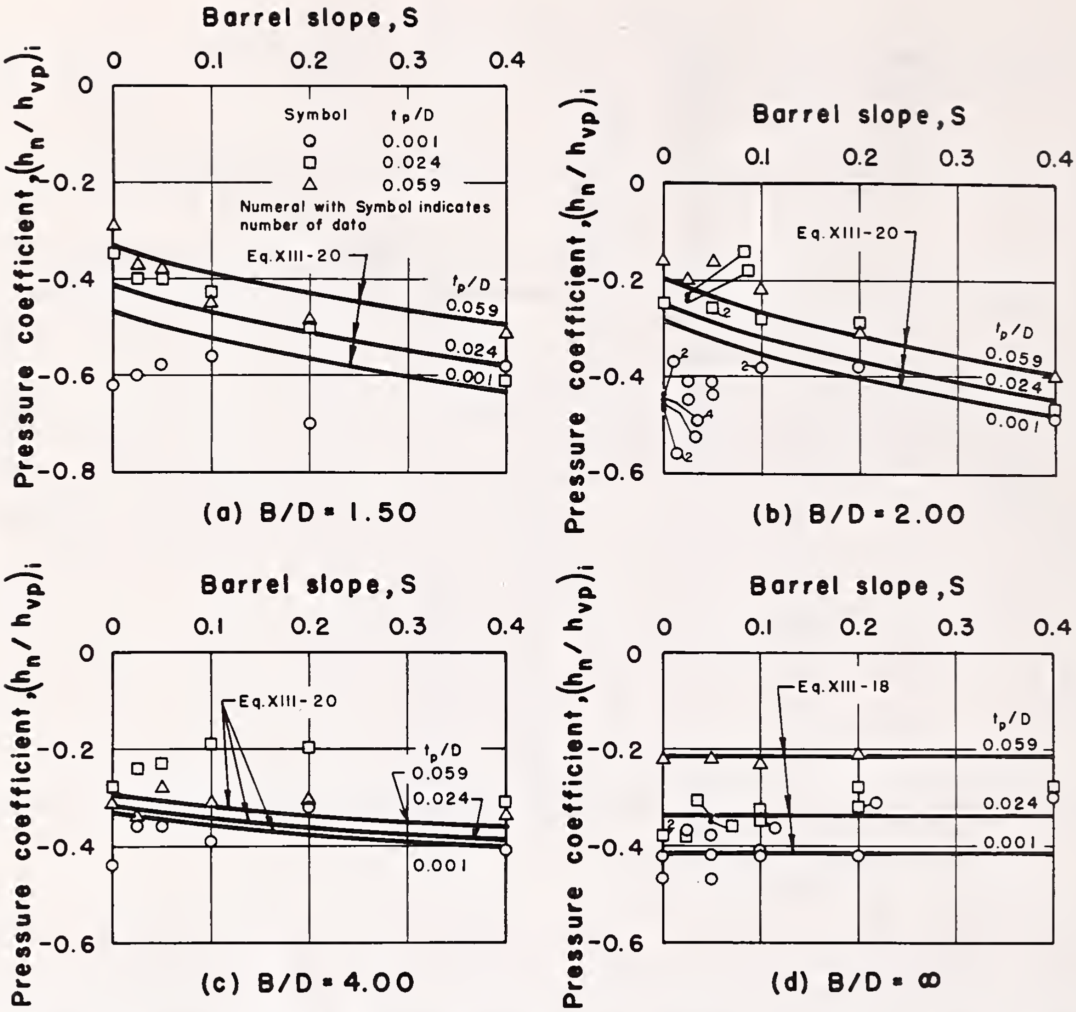


FIGURE XIII-28.—The effect of barrel slope on the invert pressure coefficient for square drop inlet—reentrant hood. $Z_i/D = 5.0$.

finitely large drop inlet (a hood inlet). The second term in equation XIII–20 was derived from the data. The term's good fit is shown by the agreement of the curves with the plotted points. The second term of equation XIII–20 also shows that the effect of the barrel slope on the pressure coefficient vanishes for drop inlets equal to or greater than 5D square.

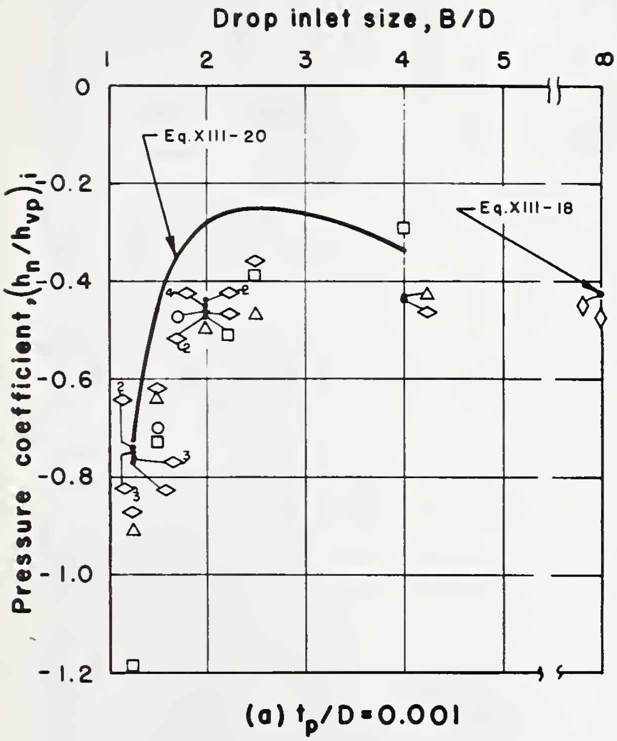
Effect of drop inlet size.—Equations XIII–17 show that the crown pressure coefficient is independent of drop inlet size except for a drop inlet 1.5D square with a thin-wall barrel entrance. For this drop inlet size the crown pressure coefficient is lower than for larger drop inlets. The exception does not apply for thick-walled barrels.

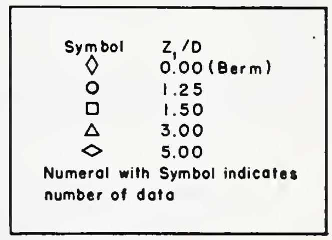
The drop inlet size has a greater effect on the invert pressure coefficients than any other variable considered during these tests. Figures XIII–29 and XIII–30 are typical plots showing the effect of the drop inlet size on the invert pressure coefficients for thin- and thick-walled barrels, respectively. The data and curves show that the pressure coefficient decreases rapidly as the drop inlet size decreases for drop inlets less than about 1.5D square. The effect of drop inlet size is represented by the third term in equation XIII–20.

The air data in figure XIII–30 indicate that the pressure coefficient increases as the drop inlet size increases until it reaches a maximum for drop inlets 2.5D square; then it decreases as the drop inlet size is further increased to 4D. As the drop inlet size increases beyond 4D, the pressure coefficients should approach the values for the hood inlets. The curves in figure XIII–30 were computed from equation XIII–20. The pressure coefficients for infinitely large drop inlets (hood in-

lets on a berm) computed from equation XIII-18 are plotted at the arrowhead on the B/D = ∞ ordinate.

The water data average, represented by the dashed line in figure XIII-30(d), indicates that the pressure coefficient increases as the drop inlet size increases until the coefficient reaches a maximum for drop inlets 2.5D square. For drop inlets larger than 2.5D square, the coefficient remains





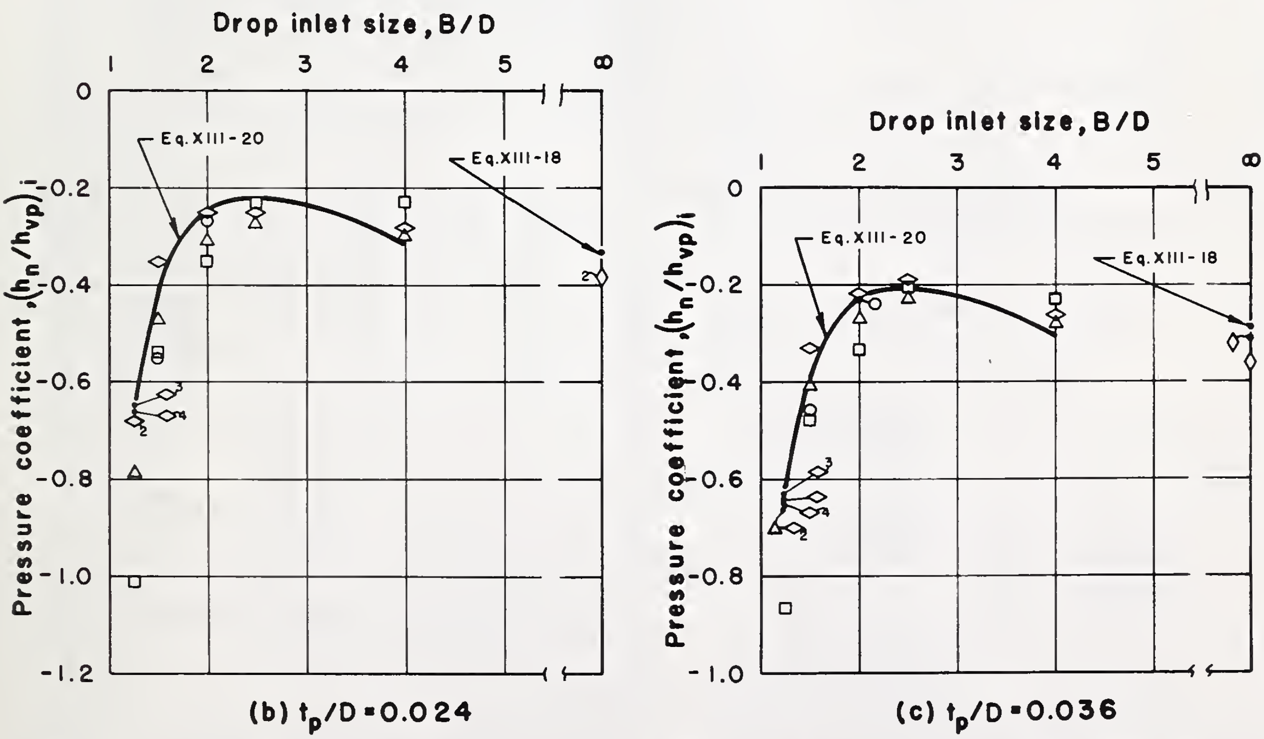


FIGURE XIII-29.—The effect of drop inlet size on the invert pressure coefficient for square drop inlet—reentrant hood and thin-walled barrels. S = 0.0.

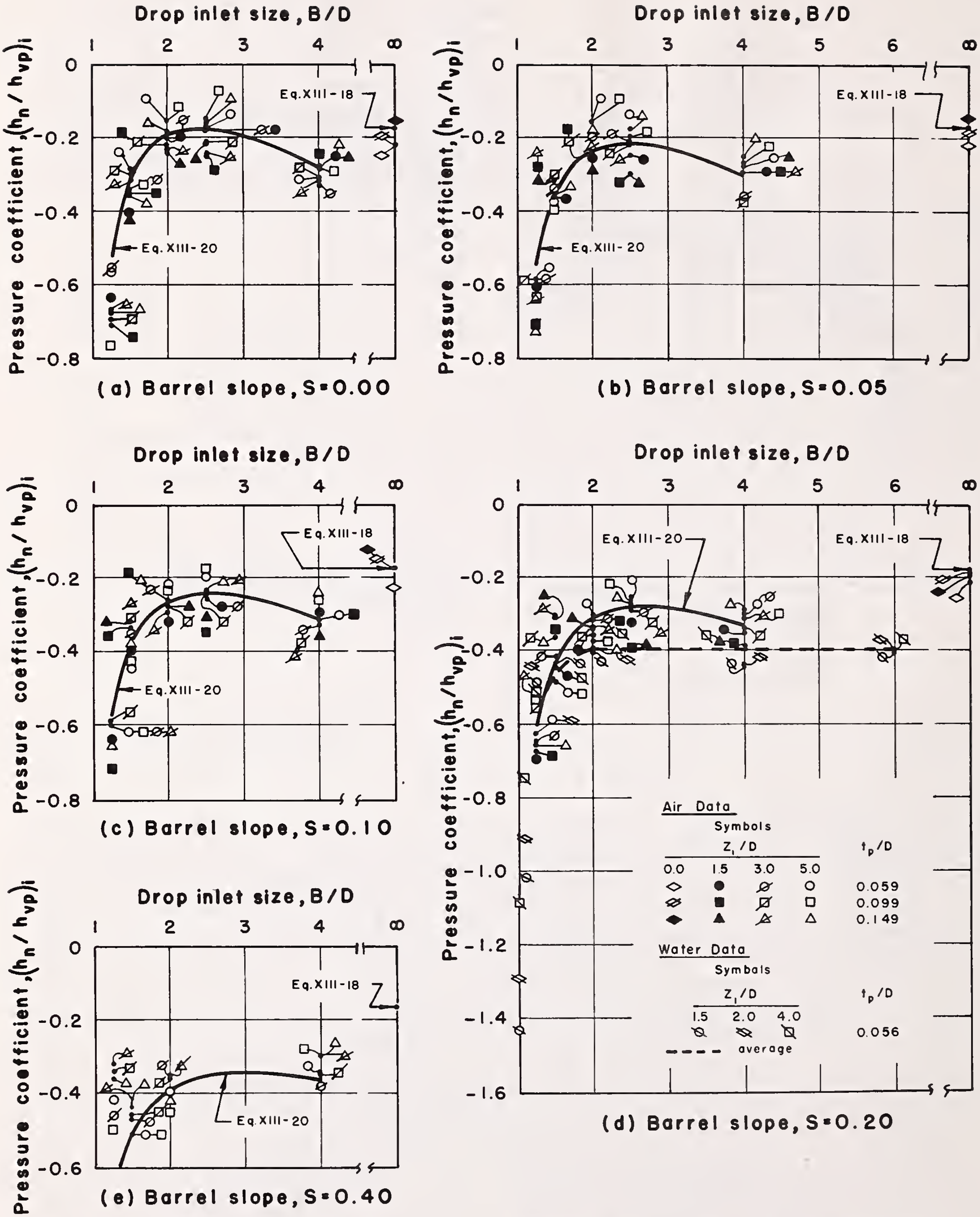


FIGURE XIII-30.—The effect of drop inlet size on the invert pressure coefficient for square drop inlet—reentrant hood hood and thick-walled barrels.

constant. Water data are available for only the 0.056D-thick barrel on a 20 percent slope.

The different trends of the pressure coefficient results between the air and water tests shown in figure XIII–30(d) cannot be explained. Because only a limited amount of water data was obtained, equations XIII–20 and XIII–18 were developed to represent the best fit for the air data. Because these data were not available for drop inlets larger than 4D square, how the computed values from equation XIII–20 approach those computed from equation XIII–18 as the drop inlet size increases could not be determined. For these drop inlets, the authors suggest that the pressure coefficients be computed from both equations XIII–20 and XIII–18 and that a value be selected based on practical considerations.

Effect of drop inlet height.—The drop inlet height had no consistent effect on and was independent of the crown pressure coefficient.

The effect of the drop inlet height on the invert pressure coefficient is shown in figure XIII–31. The data in this figure indicate there is no significant effect of the drop inlet height on the pressure coefficient for drop inlets more than 1.25D high. Equation XIII–20 can be used for computing the pressure coefficients for drop inlets equal to or greater than 1.25D high. Equation XIII–18 gives the pressure coefficients for a 0D-high drop inlet (a hood inlet on a berm). For drop inlets between zero and 1.25D high, the pressure coefficient changes linearly and can be obtained from equation XIII–19.

Precision of the equations.—No detailed analysis was made of the crown pressure coefficients. However, a comparison of equations XIII–16 and XIII–17 with the table XIII–5 (appendix) values of h_n/h_{vp} @ D/2 crown shows that the average and extreme differences between the equations and the data are ± 0.05 and ± 0.10 for the air tests. For the water tests listed in table XIII–7 (appendix), the differences range from $+0.12$ to $+0.61$.

A detailed precision analysis was made of the invert pressure coefficients. The invert pressure coefficients computed from equations XIII–18 through XIII–20 were compared with those obtained from the test data. The precision of these equations is verified against the observed data by computing the actual and percentage differences between the computed and observed values. These data are presented in table XIII–5 (appendix) for the air tests and in table XIII–7 (appendix) for the water tests.

TABLE XIII–3.—*Precision of the equations for computing the pressure loss coefficients for square drop inlets with reentrant hood barrel entrances*

Description	Drop inlet size, B/D					Total
	1.50	2.00	2.50	4.00	∞	
Number of series checked:	172	191	96	151	66	676
Average differences:						
Actual value	0.07	0.06	0.04	0.05	0.03	0.05
Percent	16.3	15.9	14.3	16.7	10.6	15.4
Maximum differences:						
Positive:						
Actual value	0.26	0.23	0.22	0.14	0.09	0.26
Percent	36	45	47	29	23	47
Negative:						
Actual value	0.24	0.12	0.07	0.17	0.12	0.24
Percent	126	50	35	113	48	126
Percent of computed values that agree with the data within:						
Actual value:						
±0.05	56	66	74	65	82	66
±0.075	68	74	81	80	89	76
±0.10	80	85	89	91	95	87
Percent:						
±5	19	19	23	24	33	22
±10	42	39	46	46	58	44
±15	65	55	58	60	79	61

Table XIII–3 gives a detailed precision analysis of the equations using the air data. The average difference without regard to sign for the 676 valid series is 15 percent or 0.05 actual. The maximum positive and negative differences are $+47$ percent (series A-1151) or $+0.26$ actual (series A-1075) and -126 percent (series A-1322) or -0.24 actual (series A-1322).

The precision of the equations was also tested using 24 water tests. The average difference without regard to sign is 17 percent or 0.07 actual. The maximum positive and negative differences are $+38$ percent (series W-157) or $+0.15$ (series W-157) actual and -6 percent (series W-115) or -0.02 actual (series W-115 and W-123).

This precision analysis shows that the precision with which equations XIII–18 through XIII–20 represent the water data is approximately equal to or better than the precision with which the equations represent the air data.

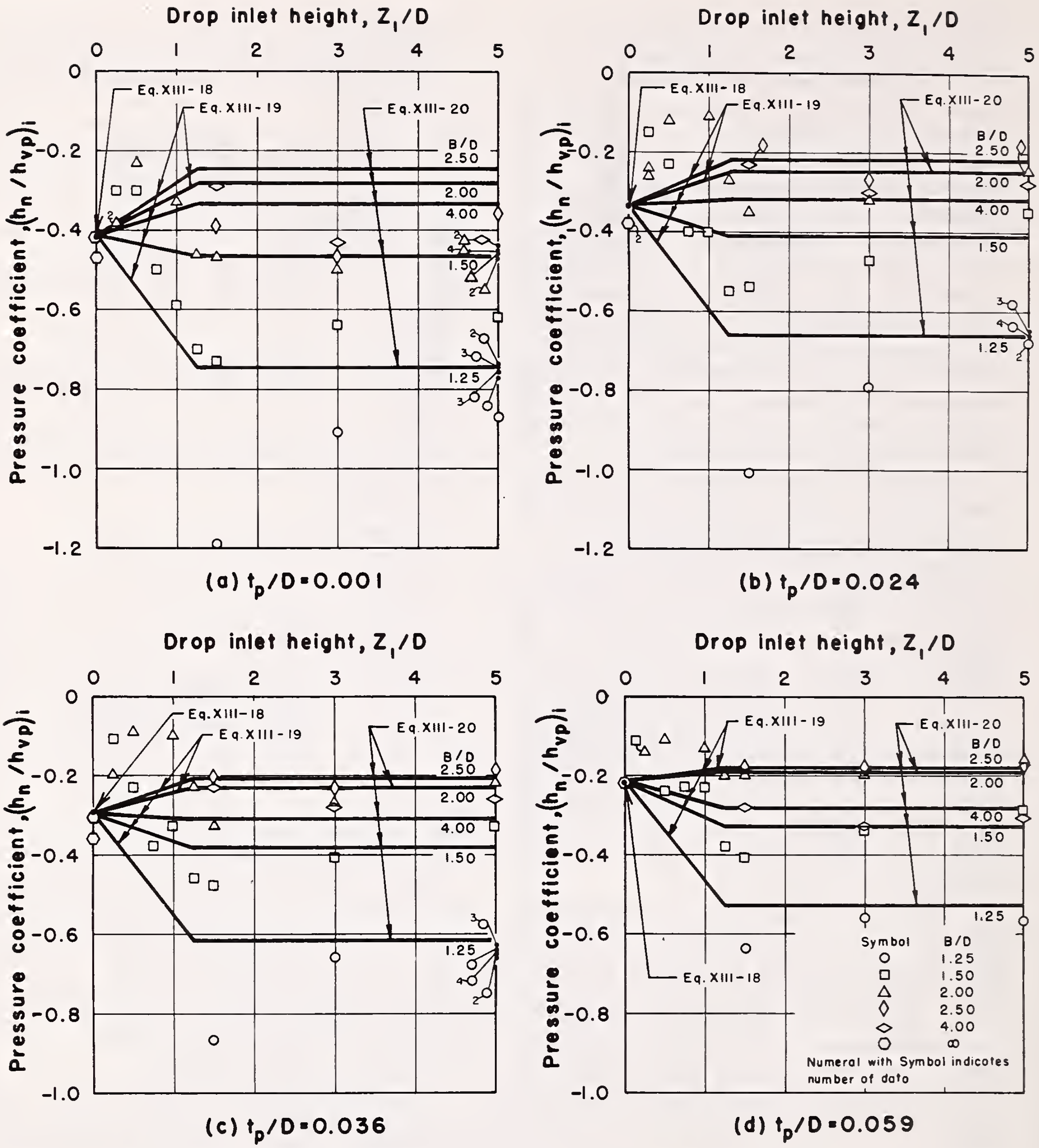


FIGURE XIII–31.—The effect of drop inlet height on the invert pressure coefficient for square drop inlet—reentrant hood. S = 0.0.

Circular drop inlet—reentrant hood

The barrel pressure coefficients at D/2 distance from the barrel entrance for circular drop inlets with reentrant hoods are presented in table XIII–6 (appendix). The effect of drop inlet size on the barrel invert pressure coefficients is shown in figure XIII–32.

Because the data on circular drop inlets are limited, no attempt was made to develop equations from this data. Instead, the data are compared with equations XIII–16 through XIII–20 de-

veloped from the square drop inlet data. Equation XIII-20, plotted in figure XIII-32, fairly well represents the trends of the circular drop inlet experimental results. As for the square drop inlet, the agreement between the water and air data plotted in figure XIII-32(d) is poor.

Comparison with the square drop inlet.—The direct comparison of the circular and the square drop inlet invert pressure coefficients in the barrel at D/2 distance from the entrance is made using the method previously adopted for comparing the entrance loss coefficients for square and circular drop inlets. The equivalent square drop inlet size used in this comparison is defined as the size of a square drop inlet that has the same area as the

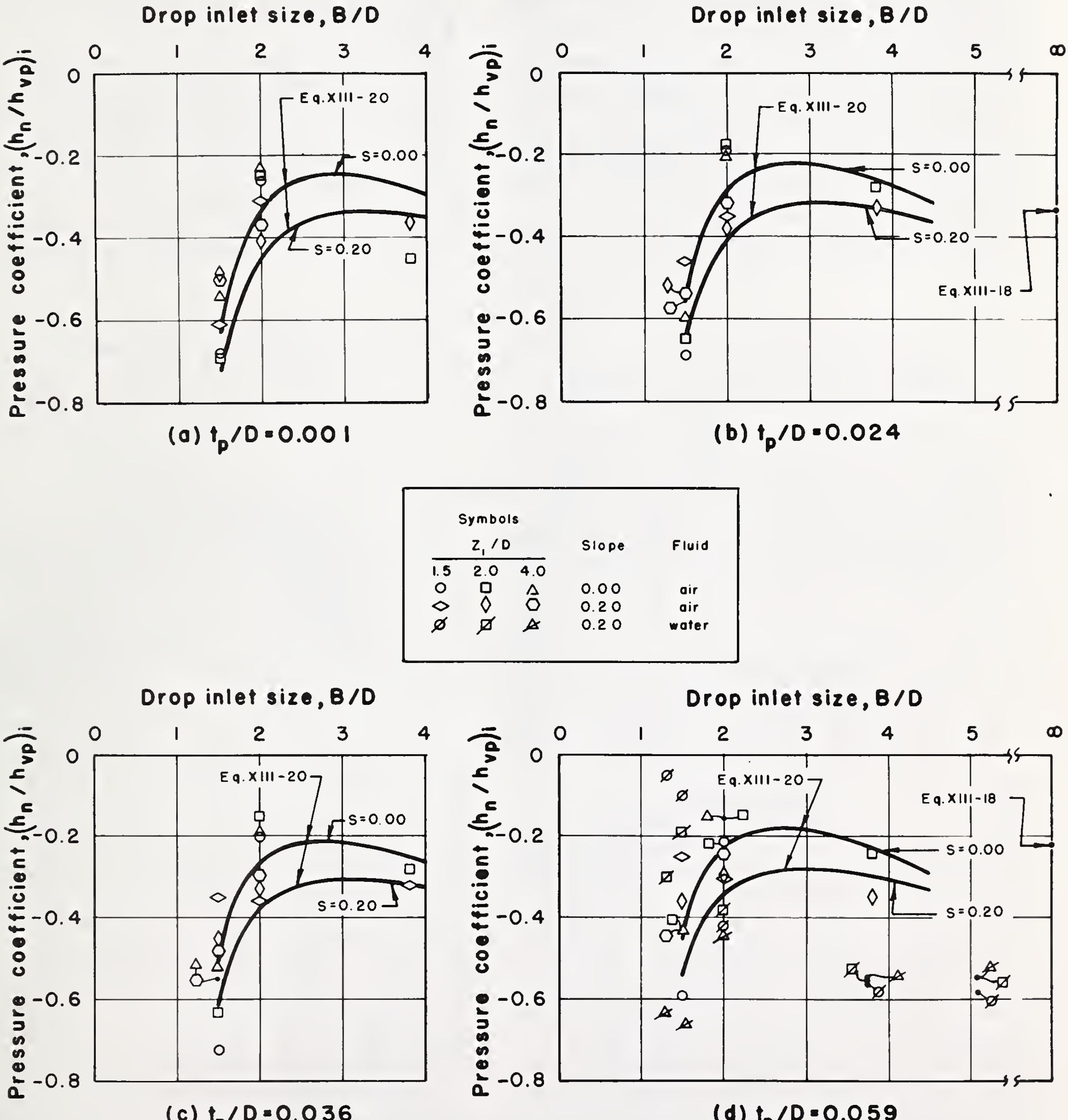


FIGURE XIII-32.—The effect of drop inlet size on the invert pressure coefficient for circular drop inlet—reentrant hood.

circular drop inlet and equals 0.886 times the diameter of a circular drop inlet.

For both circular and square drop inlets, figure XIII–33 shows data and curves for the invert pressure coefficients in the barrel at D/2 distance from the entrance. This permits the comparison of the water and air test data with equations XIII–20 and XIII–18 developed from the square hood drop inlet tests. The data in figure XIII–33 for 5D-high (open circles) and 3D-high (open hexagons) drop inlets were obtained for only air tests on square drop inlets. However, figure XIII–31 shows that the pressure coefficient is constant for drop inlets equal to or greater than 1.25D high. Therefore, the data for 5D- and 3D-high drop inlets are also used in the comparison of square and circular drop inlet test results.

The comparison of the data shown in figure XIII–33 indicates that the drop inlet shape (the square drop inlets are represented by open symbols and the circular drop inlets by similarly shaped solid symbols) does not affect the pressure coefficient in the barrel entrance. The water data in figure XIII–33(b) indicate a wide scatter, particularly for drop inlet sizes less than 1.5D. However, the general agreement between the data and the curves indicates that equation XIII–20 satisfactorily represents the data for square and circular drop inlets.

Precision of the equations.—Comparison of the values of h_n/h_{vp} @ D/2 crown in tables XIII–6 and XIII–8 (appendix) with equations XIII–17 shows the agreement to be within the limits found for the square drop inlet.

The invert pressure coefficients for circular drop inlets were computed from equations XIII–18

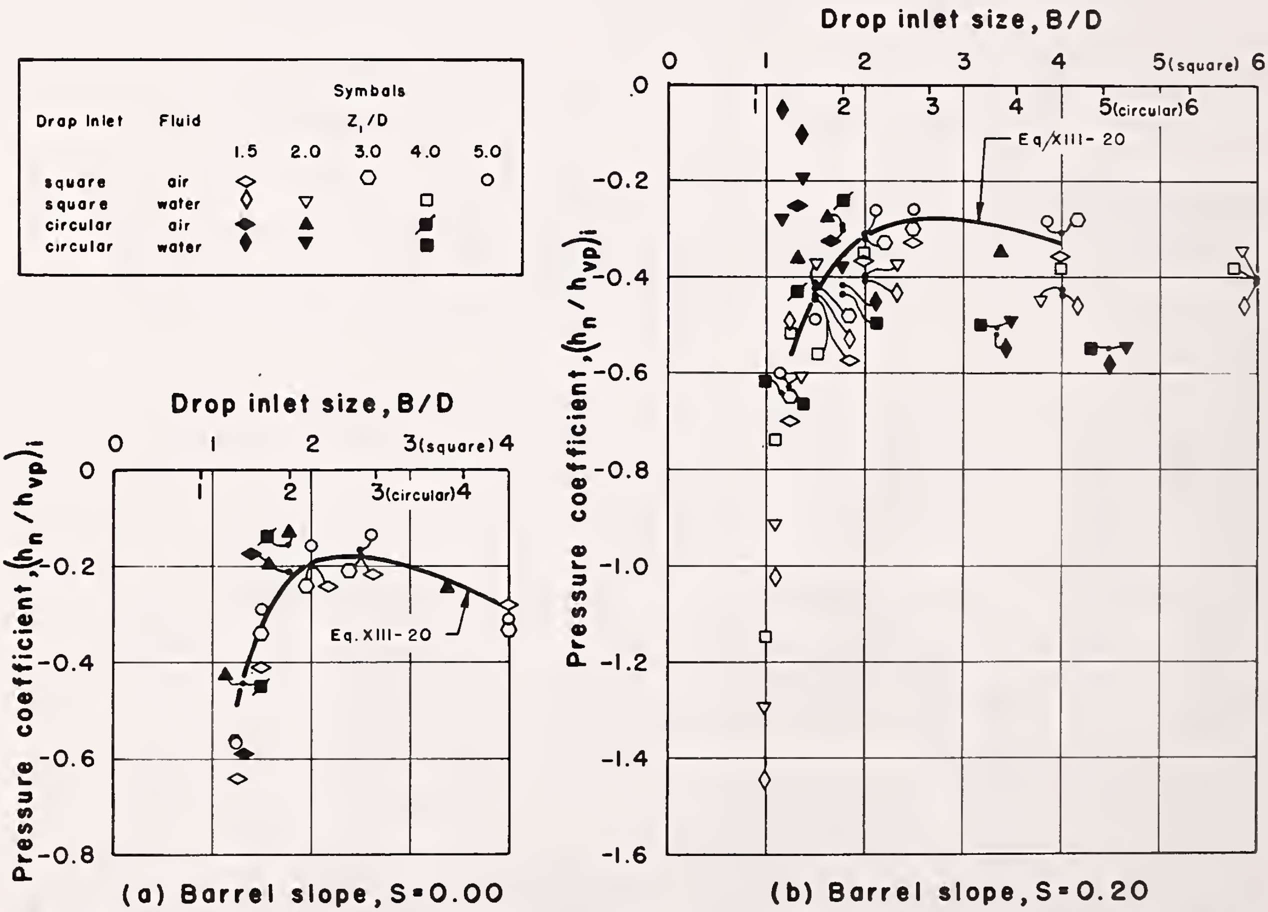


FIGURE XIII–33.—Comparison of the square and circular drop inlet invert pressure coefficients in the barrel at D/2 distance from the entrance. $t_p/D = 0.059$.

through XIII–20 after adjusting their sizes to equivalent square drop inlet sizes. The actual and percentage differences between those computed and observed were determined. These differences and the observed and computed pressure coefficients are presented in table XIII–6 (appendix) for the air tests and in table XIII–8 (appendix) for the water tests.

The average difference without regard to sign for the 41 valid air tests is 26 percent or 0.06 actual. The maximum positive and negative differences are +38 percent (series A-1514) or +0.17 actual (series A-1514) and −80 percent (series A-1547) or −0.14 actual (series A-1569).

The average difference for the 16 valid water tests is 39 percent or 0.22 actual. The maximum positive and negative differences are +59 percent (series W-210) or +0.36 actual (series W-210) and −29 percent (series W-183) or −0.08 actual (series W-183).

In addition to this numerical evaluation of the precision of the equations, the agreement of equations XIII–18 and XIII–20 with the test data is graphically presented in figures XIII–32 and XIII–33.

Square drop inlet—flush entrance hood

The flush hood barrel entrance produces smoother flow conditions in the drop inlet and barrel entrance than does the reentrant hood. The range of drop inlet sizes tested is small—from 1D to 2D square. These tests were conducted only with the water apparatus. The barrel was on a 20 percent slope. The pressure coefficients are presented in table XIII–9 (appendix).

Figure XIII–34 shows the effect of the drop inlet size on the pressure coefficient for square drop inlets ranging from 0.25D to 5D high with a flush hood barrel entrance. For adequate size drop inlets, $B \geqq 1.5D$, the plotted pressure coefficients increase with an increase in the drop inlet size. However, for too small drop inlets, $B < 1.5D$, the pressure coefficients are higher than those observed for the adequate size drop inlets. This is probably because, for small drop inlets, the flow entering the barrel is directed more toward the invert than it is for the larger drop inlets.

Because the scatter of the data is large, no attempt was made to develop an equation for the pressure coefficients. However, the flush hood results are compared with those for a reentrant hood 0.099D thick—a thick hood.

Comparison with the reentrant hood.—Figure XIII–34 compares the invert pressure coefficient data for square drop inlets with flush entrance hoods (open points) with data for reentrant hoods (solid points). For drop inlets less than 1.5D square, the flush entrance hood gives higher pressure coefficients than does the reentrant hood. This increase occurs because the flush entrance hood acts as an elbow producing higher pressures on the barrel invert than does the reentrant hood. For large drop inlets, $B \geqq 1.5D$, the pressure coefficients with a flush entrance hood are about $0.4h_{vp}$ to $0.2h_{vp}$ lower than those with a reentrant hood. Because the data are limited and their scatter is large, no attempt was made to develop an equation to represent the data. However, the flush hood entrance data are compared with equation XIII–20 developed from the reentrant hood inlet data.

Equation XIII–20 is plotted in figure XIII–34 for a thick hood, $t_p = 0.099D$. These computed coefficients are about $0.3h_{vp}$ to $0.2h_{vp}$ higher than those obtained for the flush entrance hood.

Precision of the equations.—Comparison of the values of h_n/h_{vp} @ D/2 crown in table XIII–9 (appendix) with equations XIII–17 shows the agreement to be within the limits found for the square drop inlet with a reentrant hood barrel entrance. The invert pressure coefficients for square drop inlets with flush entrance hoods were computed from equations XIII–18 through XIII–20. The pressure coefficients observed and computed, and their actual and percentage differences are presented in table XIII–9 (appendix).

The average difference without regard to sign for the 16 valid tests is 42 percent or 0.23 actual. The maximum and minimum differences are +55 percent (series W-241) or +0.34 actual (series W-234) and +30 percent (series W-222 and W-226) or +0.14 actual (series W-247 and W-251). These differences indicate that the observed pressure coefficients are lower than those computed from equations and that, if the pressure coefficients are computed using equations XIII–18 through XIII–20, they should be reduced, for the flush hood barrel entrance, by as much as about 0.3. This correction is also indicated by the information presented in figure XIII–34.

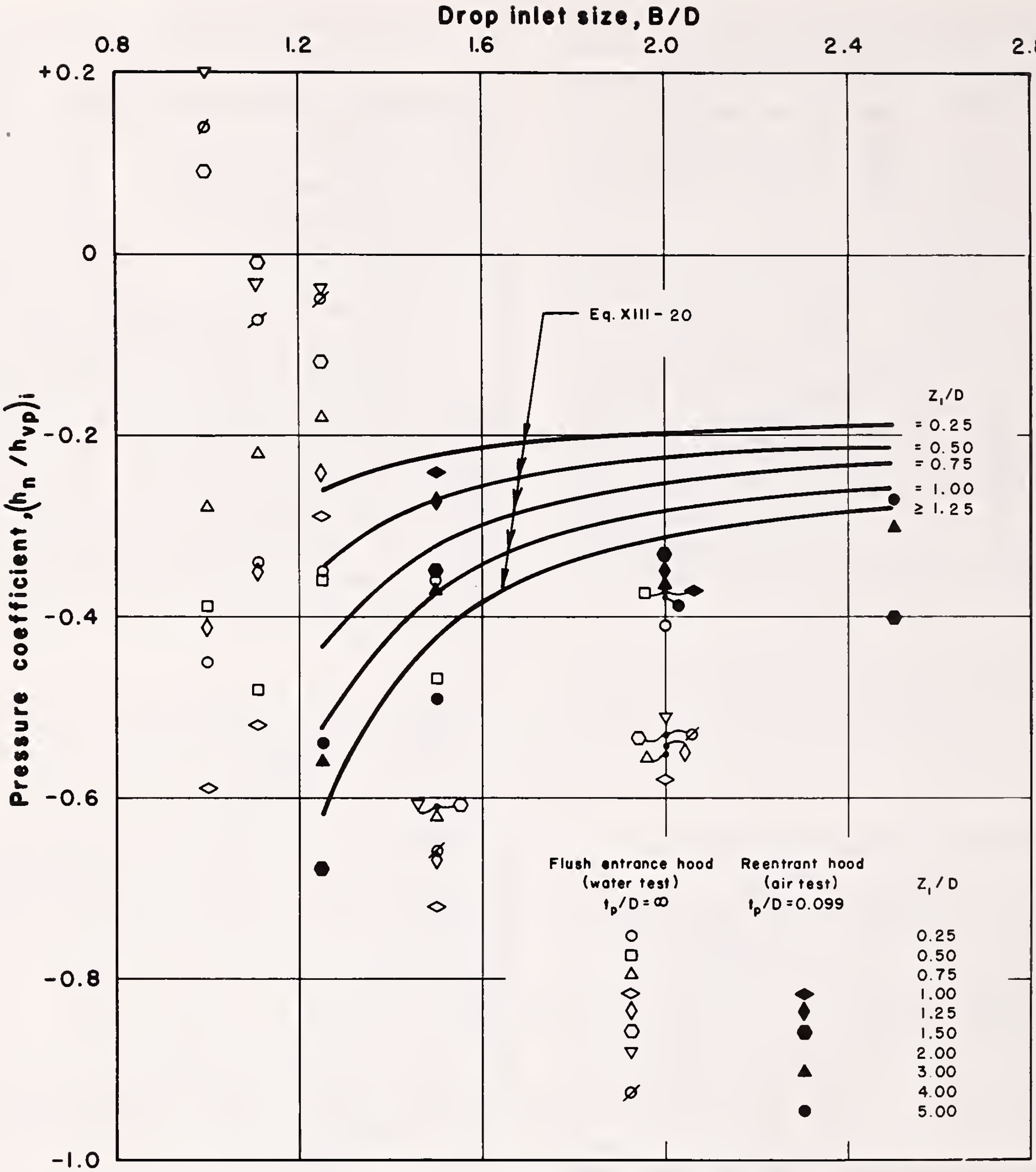


FIGURE XIII-34.—The effect of drop inlet size on the invert pressure coefficient for square drop inlet—flush entrance hood. $S = 0.20$.

Application of the Equations

A numerical example will illustrate the use of equations XIII–10 through XIII–20 for computing the entrance loss and pressure coefficients for square and circular drop inlets with reentrant hoods.

Square drop inlet—reentrant hood

EXAMPLE: Determine the entrance loss and pressure coefficients for a hood drop inlet 2D square and 3D high. The barrel is 0.05D thick and is on a 10 percent slope.

Entrance loss coefficient.—Equation XIII–10 (thin barrel) or equation XIII–11 (thick barrel) gives K_e for 5D-high drop inlets and for zero barrel slope.

Equating the expressions for K_e given by equations XIII–10 and XIII–11, compute the critical barrel wall thickness for $B/D = 2.0$.

$$0.9 + \frac{0.11}{(2.0 - 1.0)^{3/2}} - 5.0\,(2.0)^{1/2}\left(\frac{t_p}{D}\right)$$
$$= 0.47 + \frac{0.03}{(2.0 - 1.0)^{3}}$$

therefore,

$$t_{p,cr}/D = 0.072$$

Since the 0.05D barrel wall thickness is less than the 0.072D computed critical thickness, the barrel is thin. Therefore, equation XIII–10 applies. Using equation XIII–10, K_e for a 5D-high drop inlet with zero barrel slope is

$$K_e = 0.9 + \frac{0.11}{(2.0 - 1.0)^{3/2}} - 5\,(2.0)^{1/2}\,(0.05)$$
$$= 0.66$$

This entrance loss coefficient can also be obtained graphically from figure XIII–35(a).

Because this K_e is for a zero barrel slope, it must be corrected for the 10 percent slope assumed in the example.

Using equation XIII–12, $\Delta K_{e,s}$ for a 10 percent barrel slope is

$$\Delta K_{e,s} = -0.10\left\{\frac{0.42\,(2.0)^{2/3}}{(2.0 - 1.0)} - 7.5\,(0.05)\right\}$$
$$= -0.03$$

This correction can also be obtained graphically by multiplying $\Delta K_{e,s}/S$ read from figure XIII–35(b) by the slope S. Note that the slope correction is negative.

Since K_e computed using equation XIII–10 is for a 5D-high drop inlet, it must be corrected for the 3D-high drop inlet assumed for the example. Using equation XIII–14, $\Delta K_{e,z}$ for a 3D-high drop inlet is computed.

$$\Delta K_{e,z} = \frac{0.04\,(3.25 - 3.0)}{(2.0 - 1.0)}$$
$$= 0.01$$

This correction $\Delta K_{e,z}$ can also be obtained graphically from figure XIII–35(c).

Adding K_e, $\Delta K_{e,s}$ and $\Delta K_{e,z}$, the entrance loss coefficient for a 3D-high drop inlet with a 10 percent barrel slope becomes

$$K_e = 0.66 - 0.03 + 0.01 = 0.64$$

Pressure coefficient.—The pressure coefficient for a 2D-square and 3D-high drop inlet is computed from equations XIII–17a and XIII–20.

$$\left(\frac{h_n}{h_{vp}}\right)_c = -0.03$$

$$\left(\frac{h_n}{h_{vp}}\right)_i = -\left\{\frac{1.5\,\langle 0.06 - 0.05\rangle}{(2.0 - 1.0)^{2/3}}\right\} - \langle 0.4 - 0.133\,(2.0 - 2.0)\rangle\,(0.10)^{3/4} - \left\{0.07\,(2.0 - 1.0)^{5/4} + \frac{1}{(2.0)^3}\right\}$$

$$\left(\frac{h_n}{h_{vp}}\right)_i = -0.015 - 0.071 - 0.195$$
$$= -0.28$$

Whether the lowest actual pressure occurs at the crown or the invert is determined by computing h_p using equation I–14. (See Part I, page 13.)

The application of equations XIII–10 through XIII–20 for circular drop inlets is discussed next.

Circular drop inlet—reentrant hood

The entrance loss and pressure coefficients can be computed from equations XIII–10 through XIII–20 by using an equivalent size square drop inlet that has the same area as that of a circular drop inlet. This equivalent size is obtained by multiplying the circular drop inlet size by 0.886.

EXAMPLE: Determine the entrance loss and pressure coefficients for a circular drop inlet 2D in diameter and 3D high. The barrel is 0.05D thick and is on a 10 percent slope.

The circular drop inlet size is multiplied by 0.886 to convert its size to an equivalent square drop inlet size. Thus, the value for B/D used in equations XIII–10 through XIII–20 becomes

$$B/D = 0.886 \times 2.0 = 1.772$$

Using $B/D = 1.772$, the computation steps given in the above example are repeated.

The critical barrel wall thickness, $t_{p,cr}/D$	=	0.079
The K_e for 5D-high drop inlet with zero barrel slope	=	0.73
The correction for barrel slope	=	−0.04
The correction for height	=	0.01
The K_e for 2D-diameter and 3D-high drop inlet	=	0.70
The $(h_n/h_{vp})_c$ for 2D-diameter and 3D-high drop inlet	=	−0.03
The $(h_n/h_{vp})_i$ for 2D-diameter and 3D-high drop inlet	=	−0.31

Summary of Recommendations

For convenience of reference, the results of the tests on the hood drop inlet are summarized under the headings: drop inlet size, priming head, entrance loss coefficient, pressure coefficient inside the barrel entrance, and type of hood drop inlet. The correct ranges of application of the equations specified in this summary must be used because the equations representing the entrance loss and pressure coefficients apply to all three hood drop inlet entrances—the square reentrant, circular reentrant, and square flush—but over different ranges of inlet proportions. Also the equations for circular drop inlets and flush hood barrel entrances must be corrected as explained under the recommendation summary heading, Type of hood drop inlet.

Drop inlet size

Performance criteria based on the head required to cause the barrel to prime are the basis for determining the minimum size B/D of the hood drop inlet. The minimum size varies with the type of hood drop inlet and the drop inlet height Z_l. The minimum recommended values of B/D are listed in table XIII–4.

Priming head

The head H over the crest of the drop inlet at which the barrel will prime or begin to flow full depends on whether the control is the hood inlet or the drop inlet crest. It varies with the drop inlet height for low drop inlets of adequate size. For high drop inlets of adequate size, the priming head is determined by the drop inlet size—actually the length of the drop inlet crest. The priming heads are:

For the low drop inlets, $Z_l/D \leqq 1.0$

TABLE XIII–4.—*Minimum size of the hood drop inlet*

Drop inlet height	Drop inlet — Square; Hood — Reentrant	Drop inlet — Circular; Hood — Reentrant	Drop inlet — Square; Hood — Flush
	Minimum B/D		
$Z_l/D \leqq 1.00$	4.0	3.77	1.5
$1.00 < Z_l/D < 1.25$	4.0	3.77	1.5
$Z_l/D \geqq 1.25$	1.5	2.0	1.25

$$\frac{H}{D} = 1.2 - 0.8\,\frac{Z_l}{D} \qquad \text{(XIII–6)}$$

For intermediate height drop inlets, $1.0 < Z_l/D < 1.25$

No data are available to define the priming head. The authors suggest that the higher of the priming heads given by equations XIII–6 and XIII–9 be used to estimate the priming head for intermediate height drop inlets.

For high drop inlets, $Z_l/D \geqq 1.25$

$$\frac{H}{D} = C_l\left(\frac{B}{D}\right)^{-2/3} \qquad \text{(XIII–9)}$$

where, for the

square drop inlet, reentrant hood $C_l = 0.54$
circular drop inlet, reentrant hood $C_l = 0.63$
square drop inlet, flush entrance hood $C_l = 0.54$

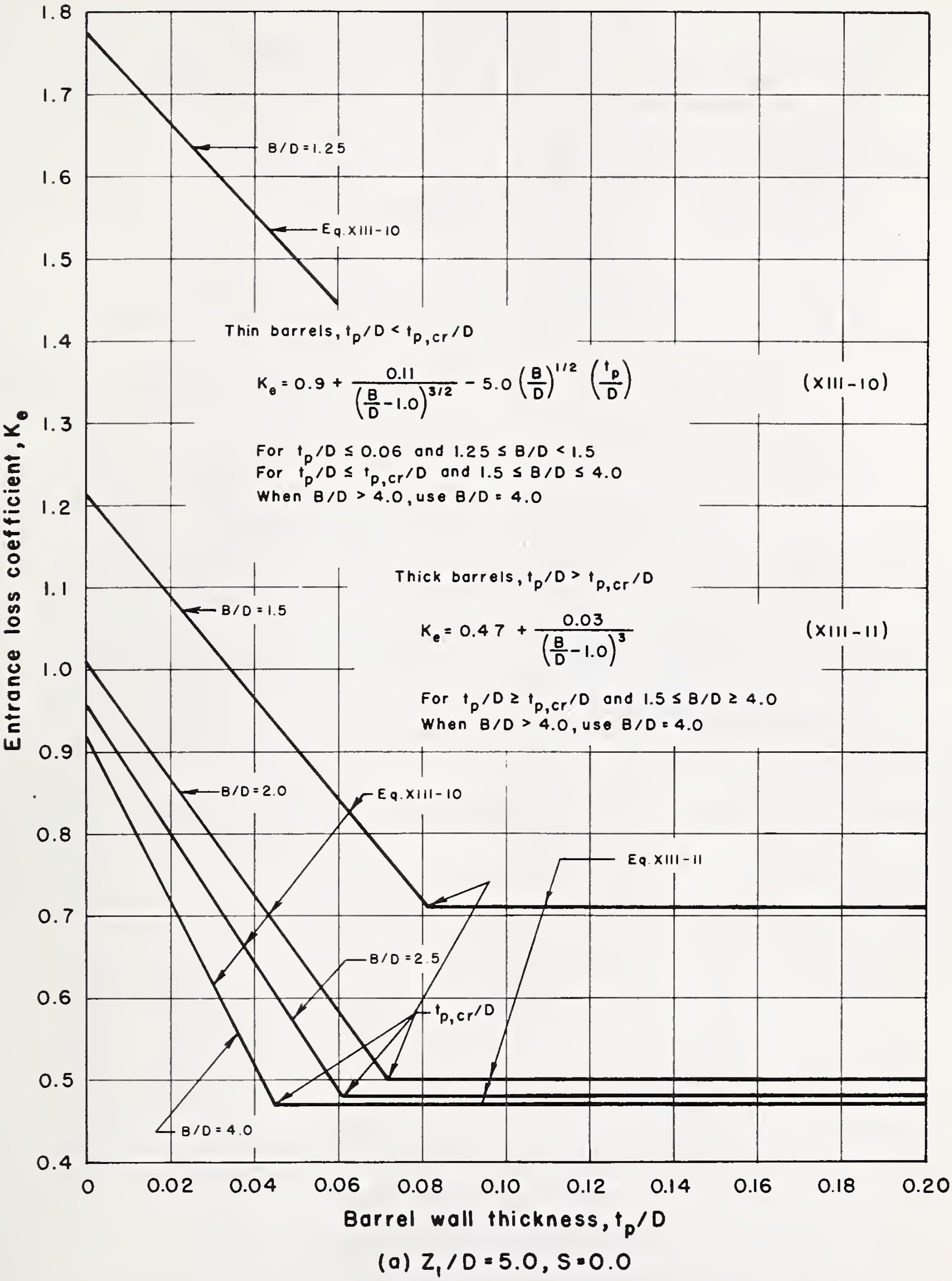
Entrance loss coefficient

The entrance loss coefficient K_e for hood drop inlets is multiplied by the velocity head in the barrel $V_p^2/2g$ to obtain the actual head loss h_e caused by the drop inlet and the hood barrel entrance. The magnitude of the coefficient depends on the barrel wall thickness t_p/D, the drop inlet size B/D, the barrel slope S, and the drop inlet height Z_l/D. The relationships are summarized in mathematical and graphical form in figure XIII–35.

The entrance loss coefficient is presented in figure XIII–35(a) for a drop inlet 5D deep with the barrel on a zero slope. To obtain $t_{p,cr}/D$, the expressions for K_e given by equations XIII–10 and XIII–11 are equated and solved for t_p/D.

The barrel slope correction is a variable for thin barrels and a constant for thick barrels. The entrance loss correction for barrel slopes other than zero $\Delta K_{e,s}$ is given in figure XIII–35(b). This correction is added algebraically to K_e obtained from figure XIII–35(a). Note that the ordinate of figure XIII–35(b) must be multiplied by S to obtain $\Delta K_{e,s}$.

The effect of the drop inlet height on the entrance loss coefficient varies with the drop inlet size. The correction for drop inlet height $\Delta K_{e,z}$ to be algebraically added to K_e determined from figure XIII–35(a) is given in figure XIII–35(c). Unfortunately data are not available to evaluate $\Delta K_{e,z}$ for relative drop inlet heights between 0.0 and 0.25. The authors suggest that the value of



(a) $Z_1/D = 5.0$, $S = 0.0$

FIGURE XIII-35.—Summary of the entrance loss coefficients: equations and typical plots.

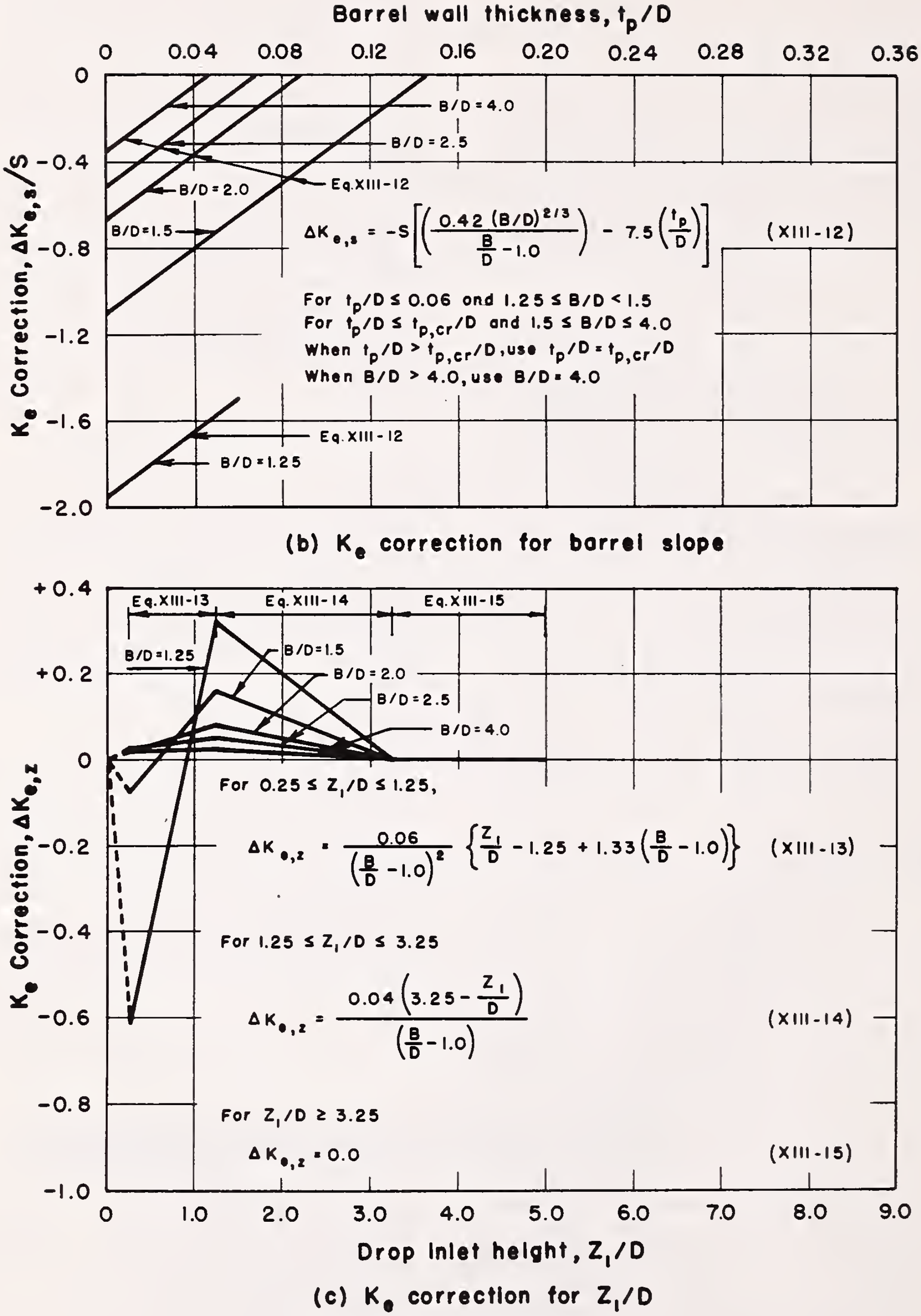


FIGURE XIII-35.—Continued.

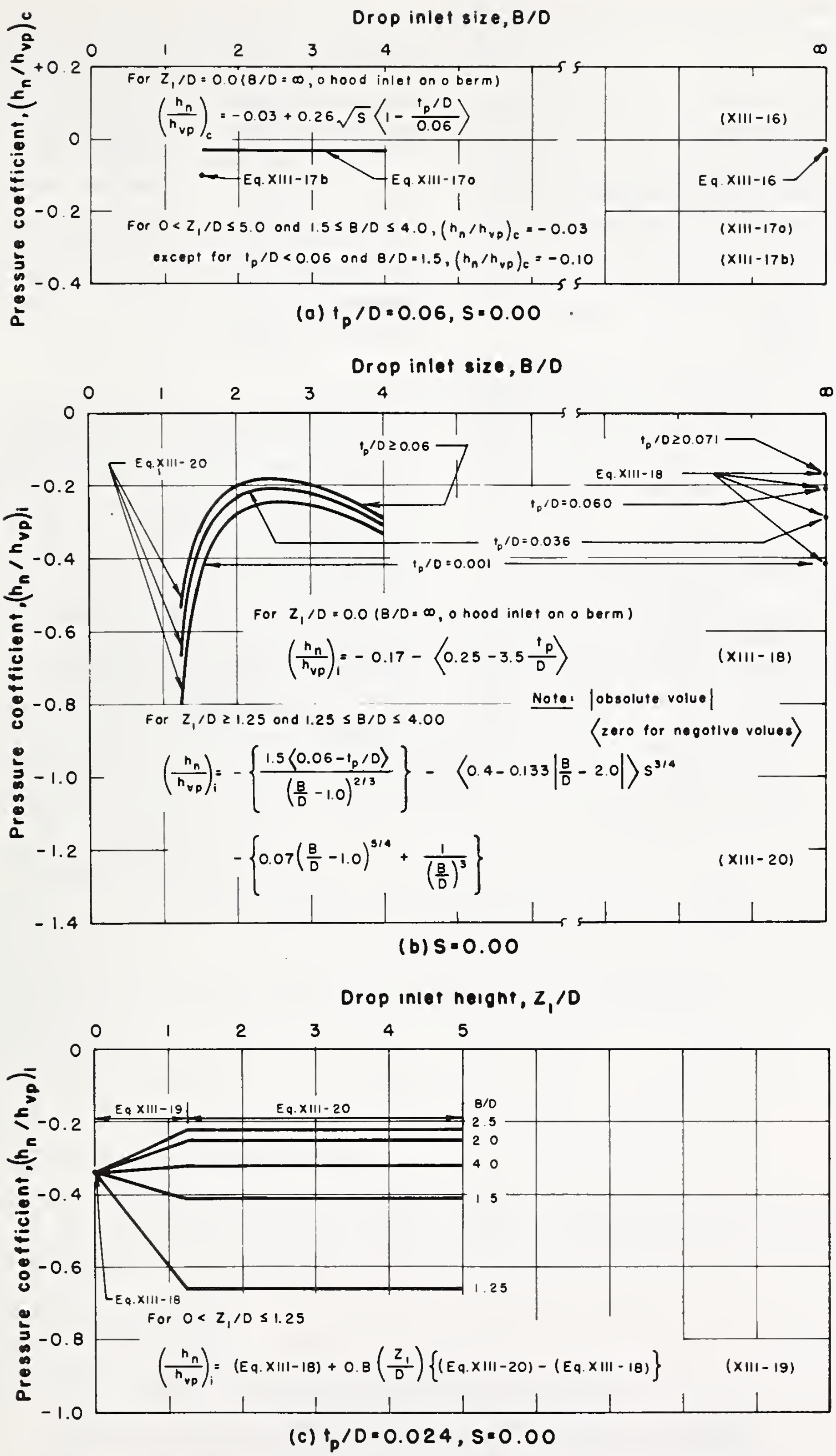


FIGURE XIII-36.—Summary of the pressure coefficients: equations and typical plots.

$\Delta K_{e,z}$ in this range be computed by linear interpolation between zero and the value computed using $Z_1/D = 0.25$ in equation XIII–13.

Pressure coefficient inside barrel entrance

The pressure coefficient h_n/h_{vp} measured on the barrel invert $D/2$ from the barrel entrance is presented mathematically and graphically in figure XIII–36. To obtain the actual pressure relative to the barrel friction grade line h_n, the pressure coefficient is multiplied by the velocity head in the barrel $h_{vp} = V_p^2/2g$.

If a flush entrance is used, the invert pressures for drop inlet sizes $B/D \geqq 1.5$ will be $0.3h_{vp}$ to $0.2h_{vp}$ lower than the values given by equation XIII–20. Thus, flush entrances are more likely to experience cavitation pressures than are reentrant entrances.

Type of hood drop inlet

The preceding recommendation summary is, except where noted, for the square drop inlet with a reentrant hood. With certain reservations the statements are valid for other types of hood drop inlets.

For circular drop inlets, the effects of discharge, barrel wall thickness, barrel slope, drop inlet size, and drop inlet height on the entrance loss and pressure coefficients are the same as those found for square drop inlets. Equations XIII–10 through XIII–20 developed from square drop inlet data can be used to determine the entrance loss and pressure coefficients for circular drop inlets after converting the circular drop inlet diameter to an equivalent square drop inlet size. This conversion is done by multiplying the circular drop inlet diameter by 0.886.

For square drop inlets with a flush hood barrel entrance, the entrance loss coefficients are nearly the same as those with a reentrant hood and can be computed from equations XIII–10 through XIII–15 when $B/D \geqq 1.5$. Reference should be made to figure XIII–25 to obtain estimates of K_e when $1.25 \leqq B/D < 1.5$. The pressure coefficients given by equations XIII–18 through XIII–20 appear to be 0.3 to 0.2 higher than those observed and a correction should be applied when $B/D \geqq 1.5$. Reference to figure XIII–34 should be made to estimate h_n/h_{vp} when $1.25 \leqq B/D < 1.5$.

Nomenclature

a	point on the headpool water surface (subscript)
B	drop inlet size: for square drop inlets, the side; for circular drop inlets, the diameter
b	performance of the drop inlet bordering between poor and satisfactory
C	weir coefficient
c	point on the barrel crown (subscript)
D	barrel diameter
e	point at the barrel entrance (subscript)
g	gravitational acceleration
h	satisfactory performance of the low drop inlets
h_e	total head loss for the drop inlet and hood inlet
h_{fb}	frictional loss in the barrel
h_{fr}	frictional loss in the drop inlet
h_n	local pressure head deviation from the friction gradeline in the barrel
h_{vp}	velocity head in the barrel $= V_p^2/2g$
H	head on the crest
i	point on the barrel invert (subscript)
K_e	entrance loss coefficient
$\Delta K_{e,s}$	correction for the effect of barrel slope on the entrance loss coefficient
$\Delta K_{e,z}$	correction for the effect of drop inlet height on the entrance loss coefficient
L	drop inlet crest length
n	point in the barrel (subscript)
p	point in the barrel (subscript); poor performance of the drop inlet
P	pressure
ΔP_n	deviation of the hydraulic gradeline from the friction gradeline
Q	discharge
$\mathbf{R}$	Reynolds number
S	barrel slope, sine
t_c	drop inlet crest wall thickness
t_p	barrel wall thickness
$t_{p,cr}$	critical barrel wall thickness—the wall thickness that separates thin and thick walls
V	velocity
w	unit weight of water
Z	elevation of a point
Z_I	height of the drop inlet, crest to inside drop inlet floor
$\langle\ \rangle$	the quantity in the pointed brackets is zero for negative numbers
$\lvert\ \rvert$	absolute value of the quantity inside
ν	kinematic viscosity

TABLE XIII–5.—*Summary of air test results for square drop inlet—reentrant hood*

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	Computed	Difference	Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 5.00				B/D = 4.00					
A-730	.000	.001	.083	.80	.91	.11	13.7	-.44	-.33	.11	25.0	.04	1
A-731	.000	.003	.083	.79	.89	.10	12.7	-.35	-.33	.02	5.7	-.05	1
A-732	.000	.013	.083	.64	.79	.15	23.4	-.29	-.33	-.04	-13.8	-.07	1
A-733	.000	.024	.083	.56	.68	.12	21.4	-.28	-.32	-.04	-14.3	-.03	1
A-734	.000	.036	.083	.51	.56	.05	9.8	-.26	-.31	-.05	-19.2	-.04	1
A-735	.000	.059	.083	.39	.47	.08	20.5	-.31	-.29	.02	6.5	-.11	1
A-736	.000	.099	.083	.41	.47	.06	14.6	-.29	-.29	.00	.0	-.09	1
A-737	.000	.149	.083	.40	.47	.07	17.5	-.28	-.29	-.01	-3.6	-.10	1
A-738	.000	.197	.083	.39	.47	.08	20.5	-.24	-.29	-.05	-20.8	-.08	1
A-739	.025	.001	.083	.87	.90	.03	3.4	-.36	-.34	.02	5.6	-.07	1
A-740	.025	.003	.083	.73	.89	.16	21.9	-.44	-.34	.10	22.7	-.08	1
A-741	.025	.013	.083	.63	.78	.15	23.8	-.31	-.33	-.02	-6.5	-.03	1
A-742	.025	.024	.083	.67	.68	.01	1.5	-.24	-.33	-.09	-37.5	-.03	1
A-743	.025	.036	.083	.59	.56	-.03	-5.1	-.15	-.32	-.17	-113.3	-.03	1
A-744	.025	.059	.083	.47	.47	.00	.0	-.34	-.30	.04	11.8	-.10	1
A-745	.025	.099	.083	.46	.47	.01	2.2	-.29	-.30	-.01	-3.4	-.09	1
A-746	.025	.149	.083	.46	.47	.01	2.2	-.26	-.30	-.04	-15.4	-.07	1
A-747	.025	.197	.083	.47	.47	.00	.0	-.23	-.30	-.07	-30.4	-.05	1
A-748	.050	.001	.083	.94	.89	-.05	-5.3	-.36	-.35	.01	2.8	-.03	1
A-749	.050	.003	.083	.89	.88	-.01	-1.1	-.34	-.35	-.01	-2.9	.06	1
A-750	.050	.013	.083	.80	.78	-.02	-2.5	-.30	-.34	-.04	-13.3	.01	1
A-751	.050	.024	.083	.70	.68	-.02	-2.9	-.23	-.33	-.10	-43.5	.02	1
A-752	.050	.036	.083	.61	.56	-.05	-8.2	-.24	-.32	-.08	-33.3	.00	1
A-753	.050	.059	.083	.48	.47	-.01	-2.1	-.28	-.31	-.03	-10.7	-.07	1
A-754	.050	.099	.083	.47	.47	.00	.0	-.27	-.31	-.04	-14.8	-.05	1
A-755	.050	.149	.083	.46	.47	.01	2.2	-.26	-.31	-.05	-19.2	-.05	1
A-756	.050	.197	.083	.47	.47	.00	.0	-.24	-.31	-.07	-29.2	-.03	1
A-757	.100	.001	.083	.89	.87	-.02	-2.2	-.39	-.36	.03	7.7	-.02	1
A-758	.100	.003	.083	.87	.86	-.01	-1.1	-.29	-.36	-.07	-24.1	-.02	1
A-759	.100	.013	.083	.77	.77	.00	.0	-.22	-.35	-.13	-59.1	-.01	1
A-760	.100	.024	.083	.68	.67	-.01	-1.5	-.19	-.34	-.15	-78.9	.01	1
A-761	.100	.036	.083	.61	.55	-.06	-9.8	-.21	-.33	-.12	-57.1	.01	1
A-762	.100	.059	.083	.50	.47	-.03	-6.0	-.31	-.32	-.01	-3.2	-.05	1
A-763	.100	.099	.083	.49	.47	-.02	-4.1	-.26	-.32	-.06	-23.1	-.04	1
A-764	.100	.149	.083	.49	.47	-.02	-4.1	-.24	-.32	-.0	-33.3	-.04	1
A-765	.100	.197	.083	.50	.47	-.03	-6.0	-.26	-.32	-.06	-23.1	-.02	1
A-766	.200	.001	.083	.89	.84	-.05	-5.6	-.32	-.38	-.06	-18.8	.03	1
A-767	.200	.003	.083	.86	.83	-.03	-3.5	-.38	-.38	.00	.0	.00	1
A-768	.200	.013	.083	.76	.74	-.02	-2.6	-.20	-.37	-.17	-85.0	.03	1
A-769	.200	.024	.083	.67	.65	-.02	-3.0	-.20	-.36	-.16	-80.0	.04	1
A-770	.200	.036	.083	.57	.54	-.03	-5.3	-.26	-.35	-.09	-34.6	.00	1
A-771	.200	.059	.083	.47	.47	.00	.0	-.31	-.33	-.02	-6.5	-.06	1
A-772	.200	.099	.083	.48	.47	-.01	-2.1	-.32	-.33	-.01	-3.1	-.04	1
A-773	.200	.149	.083	.46	.47	.01	2.2	-.30	-.33	-.03	-10.0	-.06	1
A-774	.200	.197	.083	.47	.47	.00	.0	-.27	-.33	-.06	-22.2	-.04	1
A-775	.400	.001	.083	.76	.77	.01	1.3	-.41	-.40	.01	2.4	.04	1
A-776	.400	.003	.083	.78	.76	-.02	-2.6	-.38	-.40	-.02	-5.3	.04	1
A-777	.400	.013	.083	.67	.69	.02	3.0	-.24	-.40	-.16	-66.7	.03	1
A-778	.400	.024	.083	.61	.61	.00	.0	-.31	-.39	-.08	-25.8	.03	1
A-779	.400	.036	.083	.50	.53	.03	6.0	-.27	-.38	-.11	-40.7	-.01	1
A-780	.400	.059	.083	.47	.47	.00	.0	-.34	-.36	-.02	-5.9	-.04	1
A-781	.400	.099	.083	.48	.47	-.01	-2.1	-.30	-.36	-.06	-20.0	-.03	1
A-782	.400	.149	.083	.48	.47	-.01	-2.1	-.30	-.36	-.06	-20.0	-.03	1
A-783	.400	.197	.083	.48	.47	-.01	-2.1	-.34	-.36	-.02	-5.9	-.02	1
				Z_1/D = 5.00				B/D = 2.50					
A-1107	.000	.001	.083	1.00	.95	-.05	-5.0	-.36	-.25	.11	30.6	-.08	1
A-1108	.000	.013	.083	.90	.86	-.04	-4.4	-.28	-.23	.05	17.9	-.01	1
A-1109	.000	.024	.083	.81	.77	-.04	-4.9	-.25	-.22	.03	12.0	-.01	1
A-1110	.000	.036	.083	.72	.68	-.04	-5.6	-.19	-.21	-.02	-10.5	-.01	1
A-1111	.000	.059	.083	.52	.50	-.02	-3.8	-.17	-.18	-.01	-5.9	-.04	1
A-1112	.000	.099	.083	.49	.48	-.01	-2.0	-.15	-.18	-.03	-20.0	-.05	1
A-1113	.000	.149	.083	.45	.48	.03	6.7	-.16	-.18	-.02	-12.5	-.05	1
A-1114	.000	.197	.083	.45	.48	.03	6.7	-.17	-.18	-.01	-5.9	-.01	1

See notes at end of table.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 5.00				B/D = 2.50					
A-1115	.050	.001	.083	.95	.92	-.03	-3.2	-.37	-.28	.09	24.3	-.05	1
A-1116	.050	.013	.083	.85	.84	-.01	-1.2	-.30	-.27	.03	10.0	-.01	1
A-1117	.050	.024	.083	.79	.76	-.03	-3.8	-.24	-.26	-.02	-8.3	.01	1
A-1118	.050	.036	.083	.70	.66	-.04	-5.7	-.20	-.24	-.04	-20.0	.00	1
A-1119	.050	.059	.083	.54	.49	-.05	-9.3	-.18	-.22	-.04	-22.2	-.04	1
A-1120	.050	.099	.083	.50	.48	-.02	-4.0	-.20	-.22	-.02	-10.0	-.03	1
A-1121	.050	.149	.083	.50	.48	-.02	-4.0	-.18	-.22	-.04	-22.2	-.03	1
A-1122	.050	.197	.083	.49	.48	-.01	-2.0	-.19	-.22	-.03	-15.8	-.02	1
A-1123	.100	.001	.083	.95	.90	-.05	-5.3	-.33	-.31	.02	6.1	-.05	1
A-1124	.100	.013	.083	.85	.82	-.03	-3.5	-.25	-.29	-.04	-16.0	-.01	1
A-1125	.100	.024	.083	.78	.74	-.04	-5.1	-.23	-.28	-.05	-21.7	.00	1
A-1126	.100	.036	.083	.68	.65	-.03	-4.4	-.20	-.27	-.07	-35.0	.00	1
A-1127	.100	.059	.083	.52	.49	-.03	-5.8	-.20	-.24	-.04	-20.0	-.05	1
A-1128	.100	.099	.083	.49	.47	-.02	-4.1	-.18	-.24	-.06	-33.3	-.05	1
A-1129	.100	.149	.083	.50	.47	-.03	-6.0	-.23	-.24	-.01	-4.3	-.05	1
A-1130	.100	.197	.083	.50	.47	-.03	-6.0	-.22	-.24	-.02	-9.1	-.02	1
A-1131	.200	.001	.083	.86	.85	-.01	-1.2	-.36	-.35	.01	2.8	-.09	1
A-1132	.200	.013	.083	.81	.77	-.04	-4.9	-.29	-.33	-.04	-13.8	.01	1
A-1133	.200	.024	.083	.73	.71	-.02	-2.7	-.28	-.32	-.04	-14.3	.00	1
A-1134	.200	.036	.083	.65	.63	-.02	-3.1	-.26	-.31	-.05	-19.2	.00	1
A-1135	.200	.059	.083	.51	.48	-.03	-5.9	-.26	-.28	-.02	-7.7	-.05	1
A-1136	.200	.099	.083	.50	.47	-.03	-6.0	-.27	-.28	-.01	-3.7	-.04	1
A-1137	.200	.149	.083	.49	.47	-.02	-4.1	-.28	-.28	.00	.0	-.05	1
A-1138	.200	.197	.083	.49	.47	-.02	-4.1	-.25	-.28	-.03	-12.0	-.03	1
				Z_1/D = 5.00				B/D = 2.00					
A-518	.000	.001	.084	1.02	1.00	-.02	-2.0	-.47	-.28	.19	40.4	-.08	1
A-519	.000	.001	.170	1.02	1.00	-.02	-2.0	-.44	-.28	.16	36.4	-.08	1
A-520	.000	.001	.216	1.02	1.00	-.02	-2.0	-.45	-.28	.17	37.8	-.08	1
A-521	.000	.001	.259	1.02	1.00	-.02	-2.0	-.44	-.28	.16	36.4	-.08	1
A-522	.000	.001	.300	1.00	1.00	.00	.0	-.45	-.28	.17	37.8	-.08	1
A-523	.000	.001	.403	1.00	1.00	.00	.0	-.45	-.28	.17	37.8	-.08	1
A-524	.000	.001	.599	1.00	1.00	.00	.0	-.46	-.28	.18	39.1	-.08	1
A-525	.000	.001	1.003	1.00	1.00	.00	.0	-.47	-.28	.19	40.4	-.08	1
A-526	.000	.001	4.000	.99	1.00	.01	1.0	-.45	-.28	.17	37.8	-.08	1
A-527	.000	.003	.083	1.00	.99	-.01	-1.0	-.37	-.28	.09	24.3	.02	1
A-528	.000	.013	.083	.91	.92	.01	1.1	-.30	-.27	.03	10.0	-.05	1
A-529	.000	.024	.083	.84	.84	.00	.0	-.25	-.25	.00	.0	-.03	1
A-530	.000	.036	.083	.74	.76	.02	2.7	-.22	-.23	-.01	-4.5	.00	1
A-632	.000	.059	.080	.63	.60	-.03	-4.8	-.16	-.20	-.04	-25.0	-.05	1
A-633	.000	.099	.080	.45	.50	.05	11.1	-.16	-.20	-.04	-25.0	-.05	1
A-634	.000	.149	.080	.45	.50	.05	11.1	-.18	-.20	-.02	-11.1	-.05	1
A-635	.000	.197	.080	.45	.50	.05	11.1	-.21	-.20	.01	4.8	-.05	1
A-566	.025	.001	.083	.96	.99	.03	3.1	-.44	-.31	.13	29.5	-.06	1,2
A-607	.025	.001	.083	.98	.99	.01	1.0	-.41	-.31	.10	24.4	-.03	1
A-567	.025	.003	.083	.93	.98	.05	5.4	-.36	-.31	.05	13.9	-.11	1,2
A-608	.025	.003	.083	.98	.98	.00	.0	-.41	-.31	.10	24.4	.02	1
A-568	.025	.013	.083	.87	.90	.03	3.4	-.23	-.29	-.06	-26.1	-.06	1,2
A-609	.025	.013	.083	.88	.90	.02	2.3	-.24	-.29	-.05	-20.8	-.03	1
A-569	.025	.024	.083	.77	.83	.06	7.8	-.24	-.27	-.03	-12.5	-.02	1,2
A-610	.025	.024	.083	.81	.83	.02	2.5	-.23	-.27	-.04	-17.4	-.03	1
A-570	.025	.036	.083	.74	.75	.01	1.4	-.24	-.26	-.02	-8.3	-.02	1,2
A-611	.025	.036	.083	.72	.75	.03	4.2	-.21	-.26	-.05	-23.8	-.01	1
A-636	.025	.059	.082	.60	.59	-.01	-1.7	-.20	-.22	-.02	-10.0	-.04	1
A-637	.025	.099	.082	.45	.50	.05	11.1	-.18	-.22	-.04	-22.2	-.04	1
A-638	.025	.149	.082	.48	.50	.02	4.2	-.22	-.22	.00	.0	-.04	1
A-639	.025	.197	.082	.49	.50	.01	2.0	-.26	-.22	.04	15.4	-.04	1
A-571	.050	.001	.084	1.00	.97	-.03	-3.0	-.44	-.33	.11	25.0	-.12	1,2
A-612	.050	.001	.084	.98	.97	-.01	-1.0	-.41	-.33	.08	19.5	-.04	1
A-572	.050	.003	.084	.95	.96	.01	1.1	-.30	-.32	-.02	-6.7	.02	1,2
A-613	.050	.003	.084	.96	.96	.00	.0	-.38	-.32	.06	15.8	.01	1
A-573	.050	.013	.084	.87	.89	.02	2.3	-.26	-.31	-.05	-19.2	-.06	1

See notes at end of table.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	Computed	Difference	Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 5.00				B/D = 2.00					
A-614	.050	.013	.084	.88	.89	.01	1.1	-.26	-.31	-.05	-19.2	-.04	1
A-574	.050	.024	.084	.80	.82	.02	2.5	-.26	-.29	-.03	-11.5	-.03	1,2
A-615	.050	.024	.084	.80	.82	.02	2.5	-.26	-.29	-.03	-11.5	-.03	1
A-575	.050	.036	.084	.72	.74	.02	2.8	-.23	-.27	-.04	-17.4	-.01	1
A-616	.050	.036	.084	.72	.74	.02	2.8	-.23	-.27	-.04	-17.4	-.02	1
A-640	.050	.059	.085	.61	.58	-.03	-4.9	-.16	-.24	-.08	-50.0	-.04	1
A-641	.050	.099	.085	.48	.49	.01	2.1	-.16	-.24	-.08	-50.0	-.04	1
A-642	.050	.149	.085	.47	.49	.02	4.3	-.18	-.24	-.06	-33.3	-.04	1
A-643	.050	.197	.085	.47	.49	.02	4.3	-.22	-.24	-.02	-9.1	-.04	1
A-576	.100	.001	.079	.95	.94	-.01	-1.1	-.38	-.35	.03	7.9	-.04	1
A-617	.100	.001	.079	.95	.94	-.01	-1.1	-.38	-.35	.03	7.9	-.04	1
A-618	.100	.003	.079	.95	.93	-.02	-2.1	-.41	-.35	.06	14.6	.03	1
A-619	.100	.013	.079	.86	.86	.00	.0	-.26	-.34	-.08	-30.8	-.03	1
A-620	.100	.024	.079	.79	.79	.00	.0	-.28	-.32	-.04	-14.3	-.01	1
A-621	.100	.036	.079	.69	.72	.03	4.3	-.22	-.30	-.08	-36.4	-.01	1
A-644	.100	.059	.079	.58	.57	-.01	-1.7	-.22	-.27	-.05	-22.7	-.04	1
A-645	.100	.099	.079	.51	.49	-.02	-3.9	-.24	-.27	-.03	-12.5	-.04	1
A-646	.100	.149	.079	.50	.49	-.01	-2.0	-.26	-.27	-.01	-3.8	-.04	1
A-647	.100	.197	.079	.48	.49	.01	2.1	-.30	-.27	.03	10.0	-.04	1
A-622	.200	.001	.079	.88	.87	-.01	-1.1	-.38	-.40	-.02	-5.3	-.02	1
A-623	.200	.003	.079	.88	.86	-.02	-2.3	-.44	-.40	.04	9.1	.03	1
A-624	.200	.013	.079	.80	.81	.01	1.2	-.27	-.39	-.12	-44.4	-.02	1
A-625	.200	.024	.079	.75	.75	.00	.0	-.29	-.37	-.08	-27.6	-.02	1
A-626	.200	.036	.079	.67	.68	.01	1.5	-.27	-.35	-.08	-29.6	-.01	1
A-648	.200	.059	.079	.57	.55	-.02	-3.5	-.31	-.32	-.01	-3.2	-.04	1
A-649	.200	.099	.079	.49	.48	-.01	-2.0	-.38	-.31	.07	18.4	-.06	1
A-650	.200	.149	.079	.50	.48	-.02	-4.0	-.40	-.31	.09	22.5	-.06	1
A-651	.200	.197	.079	.49	.48	-.01	-2.0	-.43	-.31	.12	27.9	-.06	1
A-627	.400	.001	.081	.82	.74	-.08	-9.8	-.49	-.48	.01	2.0	.00	1
A-628	.400	.003	.081	.81	.73	-.08	-9.9	-.50	-.48	.02	4.0	.04	1
A-629	.400	.013	.081	.73	.69	-.04	-5.5	-.43	-.47	-.04	-9.3	-.02	1
A-630	.400	.024	.081	.68	.65	-.03	-4.4	-.47	-.45	.02	4.3	-.04	1
A-631	.400	.036	.081	.61	.60	-.01	-1.6	-.43	-.43	.00	.0	-.04	1
				Z_1/D = 4.93				B/D = 2.00					
A-652	.400	.059	.081	.51	.51	.00	.0	-.40	-.40	.00	.0	-.06	1
A-653	.400	.099	.081	.51	.45	-.06	-11.8	-.45	-.40	.05	11.1	-.06	1
A-654	.400	.149	.081	.51	.45	-.06	-11.8	-.42	-.40	.02	4.8	-.06	1
A-655	.400	.197	.081	.48	.45	-.03	-6.3	-.44	-.40	.04	9.1	-.06	1
				Z_1/D = 4.99				B/D = 1.50					
A-534	.000	.001	.078	1.24	1.21	-.03	-2.4	-.62	-.47	.15	24.2	-.12	1
A-535	.000	.003	.078	1.23	1.20	-.03	-2.4	-.60	-.46	.14	23.3	-.02	1
A-536	.000	.013	.078	1.08	1.13	.05	4.6	-.46	-.44	.02	4.3	-.10	1
A-537	.000	.024	.078	.98	1.07	.09	9.2	-.34	-.41	-.07	-20.6	-.07	1
A-538	.000	.036	.078	.98	.99	.01	1.0	-.33	-.38	-.05	-15.2	-.07	1
A-656	.000	.059	.078	.84	.85	.01	1.2	-.29	-.33	-.04	-13.8	-.07	1
A-657	.000	.099	.078	.76	.71	-.05	-6.6	-.35	-.33	.02	5.7	-.07	1
A-658	.000	.149	.078	.71	.71	.00	.0	-.37	-.33	.04	10.8	-.04	1
A-659	.000	.197	.078	.77	.71	-.06	-7.8	-.35	-.33	.02	5.7	-.05	1
				Z_1/D = 5.00				B/D = 1.50					
A-539	.025	.001	.079	1.25	1.18	-.07	-5.6	-.60	-.49	.11	18.3	-.11	1
A-540	.025	.003	.079	1.24	1.17	-.07	-5.6	-.63	-.48	.15	23.8	-.03	1
A-541	.025	.013	.079	1.12	1.11	-.01	-.9	-.43	-.46	-.03	-7.0	-.11	1
A-542	.025	.024	.079	1.02	1.05	.03	2.9	-.40	-.43	-.03	-7.5	-.08	1
A-543	.025	.036	.079	.94	.97	.03	3.2	-.36	-.40	-.04	-11.1	-.07	1
A-660	.025	.059	.079	.84	.84	.00	.0	-.37	-.35	.02	5.4	-.11	1
A-661	.025	.099	.079	.76	.70	-.06	-7.9	-.37	-.35	.02	5.4	-.07	1
A-662	.025	.149	.079	.69	.70	.01	1.4	-.37	-.35	.02	5.4	-.05	1
A-663	.025	.197	.079	.72	.70	-.02	-2.8	-.33	-.35	-.02	-6.1	-.05	1

See notes at end of table.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 5.00				B/D = 1.50					
A-544	.050	.001	.086	1.19	1.15	-.04	-3.4	-.58	-.50	.08	13.8	-.12	1
A-545	.050	.003	.086	1.20	1.14	-.06	-5.0	-.63	-.50	.13	20.6	-.02	1
A-546	.050	.013	.086	1.06	1.08	.02	1.9	-.42	-.47	-.05	-11.9	-.10	1
A-547	.050	.024	.086	1.00	1.02	.02	2.0	-.40	-.45	-.05	-12.5	-.09	1
A-548	.050	.036	.086	.93	.95	.02	2.2	-.36	-.42	-.06	-16.7	-.08	1
A-664	.050	.059	.086	.83	.82	-.01	-1.2	-.38	-.36	.02	5.3	-.10	1
A-665	.050	.099	.086	.74	.69	-.05	-6.8	-.40	-.36	.04	10.0	-.06	1
A-666	.050	.149	.086	.65	.69	.04	6.2	-.35	-.36	-.01	-2.9	-.04	1
A-667	.050	.197	.086	.67	.69	.02	3.0	-.35	-.36	-.01	-2.9	-.06	1
A-549	.100	.001	.079	1.15	1.10	-.05	-4.3	-.56	-.53	.03	5.4	-.10	1
A-550	.100	.003	.079	1.13	1.09	-.04	-3.5	-.60	-.52	.08	13.3	-.04	1
A-551	.100	.013	.079	1.02	1.03	.01	1.0	-.40	-.50	-.10	-25.0	-.12	1
A-552	.100	.024	.079	.95	.98	.03	3.2	-.43	-.47	-.04	-9.3	-.10	1
A-553	.100	.036	.079	.94	.91	-.03	-3.2	-.50	-.44	.06	12.0	-.11	1
A-668	.100	.059	.079	.79	.79	.00	.0	-.45	-.39	.06	13.3	-.09	1
A-669	.100	.099	.079	.72	.66	-.06	-8.3	-.43	-.39	.04	9.3	-.05	1
A-670	.100	.149	.079	.65	.66	.01	1.5	-.38	-.39	-.01	-2.6	-.03	1
A-671	.100	.197	.079	.67	.66	-.01	-1.5	-.38	-.39	-.01	-2.6	-.05	1
A-554	.200	.001	.079	1.08	.99	-.09	-8.3	-.70	-.57	.13	18.6	-.08	1
A-555	.200	.003	.079	1.04	.98	-.06	-5.8	-.60	-.56	.04	6.7	-.14	1
A-556	.200	.013	.079	.94	.93	-.01	-1.1	-.50	-.54	-.04	-8.0	-.14	1
A-557	.200	.024	.079	.86	.88	.02	2.3	-.50	-.51	-.01	-2.0	-.12	1
A-558	.200	.036	.079	.84	.83	-.01	-1.2	-.50	-.48	.02	4.0	-.08	1
A-672	.200	.059	.079	.77	.72	-.05	-6.5	-.49	-.43	.06	12.2	-.09	1
A-673	.200	.099	.079	.69	.61	-.08	-11.6	-.49	-.43	.06	12.2	-.06	1
A-674	.200	.149	.079	.62	.61	-.01	-1.6	-.37	-.43	-.06	-16.2	-.05	1
A-675	.200	.197	.079	.60	.61	.01	1.7	-.39	-.43	-.04	-10.3	-.06	1
A-559	.400	.001	.082	.84	.77	-.07	-8.3	-.58	-.63	-.05	-8.6	-.07	1
A-560	.400	.003	.082	.82	.77	-.05	-6.1	-.54	-.63	-.09	-16.7	-.10	1
A-561	.400	.013	.082	.73	.73	.00	.0	-.46	-.61	-.15	-32.6	-.08	1
A-562	.400	.024	.082	.73	.70	-.03	-4.1	-.61	-.58	.03	4.9	-.07	1
A-563	.400	.036	.082	.68	.66	-.02	-2.9	-.54	-.55	-.01	-1.9	-.04	1
A-676	.400	.059	.082	.64	.59	-.05	-7.8	-.51	-.50	.01	2.0	-.06	1
A-677	.400	.099	.082	.57	.52	-.05	-8.8	-.51	-.49	.02	3.9	-.03	1
A-678	.400	.149	.082	.57	.52	-.05	-8.8	-.44	-.49	-.05	-11.4	-.01	1
A-679	.400	.197	.082	.56	.52	-.04	-7.1	-.49	-.49	.00	.0	-.06	1
				Z_1/D = 4.99				B/D = 1.25					
A-471	.000	.001	.086	1.78	----	----	----	-.75	----	----	----	-.09	3
A-472	.000	.001	.173	1.78	----	----	----	-.75	----	----	----	-.10	3
A-473	.000	.001	.214	1.79	----	----	----	-.74	----	----	----	-.11	3
A-474	.000	.001	.259	1.78	----	----	----	-.74	----	----	----	-.10	3
A-516	.000	.001	.260	1.86	----	----	----	-.87	----	----	----	-.06	3
A-475	.000	.001	.300	1.77	----	----	----	-.77	----	----	----	-.14	3
A-476	.000	.001	.402	1.79	----	----	----	-.75	----	----	----	-.12	3
A-477	.000	.001	.603	1.82	----	----	----	-.76	----	----	----	-.10	3
A-478	.000	.001	1.001	1.81	----	----	----	-.76	----	----	----	-.09	3
A-479	.000	.001	4.003	1.79	----	----	----	-.76	----	----	----	-.10	3
A-480	.000	.003	.086	1.84	----	----	----	-.86	----	----	----	-.05	3
A-481	.000	.003	.173	1.81	----	----	----	-.83	----	----	----	-.04	3
A-482	.000	.003	.216	1.82	----	----	----	-.83	----	----	----	-.04	3
A-483	.000	.003	.259	1.83	----	----	----	-.83	----	----	----	-.04	3
A-484	.000	.003	.300	1.83	----	----	----	-.84	----	----	----	-.04	3
A-485	.000	.003	.402	1.85	----	----	----	-.84	----	----	----	-.04	3
A-486	.000	.003	.602	1.87	----	----	----	-.84	----	----	----	-.04	3
A-487	.000	.003	1.001	1.85	----	----	----	-.83	----	----	----	-.03	3
A-488	.000	.003	4.010	1.84	----	----	----	-.83	----	----	----	-.04	3
A-489	.000	.013	.086	1.72	----	----	----	-.72	----	----	----	-.11	3
A-490	.000	.013	.173	1.72	----	----	----	-.72	----	----	----	-.10	3
A-491	.000	.013	.215	1.73	----	----	----	-.70	----	----	----	-.11	3
A-492	.000	.013	.300	1.72	----	----	----	-.71	----	----	----	-.10	3
A-493	.000	.013	.259	1.73	----	----	----	-.70	----	----	----	-.10	3
A-494	.000	.013	.402	1.73	----	----	----	-.71	----	----	----	-.12	3
A-495	.000	.013	.602	1.71	----	----	----	-.70	----	----	----	-.10	3

See notes at end of table.

Table XIII-5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	Computed	Difference	Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 4.99				B/D = 1.25					
A- 496	.000	.013	1.000	1.71	----	----	----	-.70	----	----	----	-.09	3
A- 497	.000	.013	4.007	1.73	----	----	----	-.70	----	----	----	-.10	3
A- 498	.000	.024	.086	1.72	----	----	----	-.68	----	----	----	-.07	3
A- 499	.000	.024	.173	1.60	----	----	----	-.66	----	----	----	-.08	3
A- 500	.000	.024	.215	1.62	----	----	----	-.65	----	----	----	-.06	3
A- 501	.000	.024	.259	1.64	----	----	----	-.65	----	----	----	-.06	3
A- 502	.000	.024	.301	1.65	----	----	----	-.65	----	----	----	-.06	3
A- 503	.000	.024	.402	1.64	----	----	----	-.66	----	----	----	-.06	3
A- 504	.000	.024	.602	1.65	----	----	----	-.66	----	----	----	-.06	3
A- 505	.000	.024	1.001	1.67	----	----	----	-.66	----	----	----	-.06	3
A- 506	.000	.024	4.007	1.67	----	----	----	-.68	----	----	----	-.06	3
A- 507	.000	.036	.086	1.65	----	----	----	-.65	----	----	----	-.03	3
A- 533	.000	.036	.086	1.72	----	----	----	-.63	----	----	----	-.10	3,4
A- 508	.000	.036	.173	1.66	----	----	----	-.66	----	----	----	-.04	3
A- 509	.000	.036	.216	1.66	----	----	----	-.65	----	----	----	-.04	3
A- 510	.000	.036	.259	1.66	----	----	----	-.65	----	----	----	-.04	3
A- 511	.000	.036	.301	1.66	----	----	----	-.65	----	----	----	-.04	3
A- 512	.000	.036	.403	1.66	----	----	----	-.63	----	----	----	-.04	3
A- 513	.000	.036	.602	1.65	----	----	----	-.64	----	----	----	-.04	3
A- 514	.000	.036	1.001	1.66	----	----	----	-.63	----	----	----	-.09	3
A- 515	.000	.036	4.007	1.71	----	----	----	-.66	----	----	----	-.06	3
A- 705	.000	.059	.080	1.62	----	----	----	-.57	----	----	----	-.19	3
A- 706	.000	.099	.080	1.91	----	----	----	-.77	----	----	----	-.50	3
A- 707	.000	.149	.080	2.59	----	----	----	-.68	----	----	----	-.14	3
A- 708	.000	.197	.080	3.46	----	----	----	-.75	----	----	----	.03	3
A- 680	.025	.001	.080	1.77	----	----	----	-.86	----	----	----	-.03	3
A- 681	.025	.003	.080	1.78	----	----	----	-.83	----	----	----	-.01	3
A- 682	.025	.013	.080	1.67	----	----	----	-.70	----	----	----	-.10	3
A- 683	.025	.024	.080	1.67	----	----	----	-.70	----	----	----	-.03	3
A- 684	.025	.036	.080	1.60	----	----	----	-.61	----	----	----	-.07	3
A- 709	.025	.059	.080	1.54	----	----	----	-.56	----	----	----	-.18	3
A- 710	.025	.099	.080	1.72	----	----	----	-.69	----	----	----	-.40	3,5
A- 729	.025	.099	.080	1.78	----	----	----	-.72	----	----	----	-.40	3
A- 711	.025	.149	.080	2.20	----	----	----	-.67	----	----	----	-.15	3
A- 712	.025	.197	.080	2.97	----	----	----	-.68	----	----	----	.04	3
				Z_1/D = 5.00				B/D = 1.25					
A- 685	.050	.001	.080	1.62	----	----	----	-.71	----	----	----	-.02	3
A- 686	.050	.003	.080	1.70	----	----	----	-.86	----	----	----	-.02	3
A- 687	.050	.013	.080	1.58	----	----	----	-.75	----	----	----	-.10	3
A- 688	.050	.024	.080	1.54	----	----	----	-.71	----	----	----	-.08	3
A- 689	.050	.036	.080	1.49	----	----	----	-.63	----	----	----	-.06	3
A- 713	.050	.059	.080	1.46	----	----	----	-.59	----	----	----	-.12	3
A- 714	.050	.099	.080	1.51	----	----	----	-.63	----	----	----	-.28	3
A- 715	.050	.149	.080	1.93	----	----	----	-.73	----	----	----	-.14	3
A- 716	.050	.197	.080	2.48	----	----	----	-.78	----	----	----	-.01	3
A- 690	.100	.001	.080	1.55	----	----	----	-.73	----	----	----	-.08	3
A- 691	.100	.003	.080	1.58	----	----	----	-.80	----	----	----	-.05	3
A- 692	.100	.013	.080	1.50	----	----	----	-.68	----	----	----	-.09	3
A- 693	.100	.024	.080	1.46	----	----	----	-.68	----	----	----	-.06	3
A- 694	.100	.036	.080	1.40	----	----	----	-.64	----	----	----	-.06	3
A- 717	.100	.059	.080	1.31	----	----	----	-.60	----	----	----	-.09	3
A- 718	.100	.099	.080	1.32	----	----	----	-.60	----	----	----	-.26	3
A- 719	.100	.149	.080	1.58	----	----	----	-.66	----	----	----	-.15	3
A- 720	.100	.197	.080	1.83	----	----	----	-.71	----	----	----	-.01	3
A- 695	.200	.001	.080	1.39	----	----	----	-.65	----	----	----	-.13	3
A- 696	.200	.003	.080	1.38	----	----	----	-.73	----	----	----	-.08	3
A- 697	.200	.013	.080	1.30	----	----	----	-.67	----	----	----	-.08	3
A- 698	.200	.024	.080	1.20	----	----	----	-.69	----	----	----	-.07	3
A- 699	.200	.036	.080	1.15	----	----	----	-.62	----	----	----	-.05	3
A- 721	.200	.059	.080	1.10	----	----	----	-.63	----	----	----	-.09	3
A- 722	.200	.099	.080	1.04	----	----	----	-.54	----	----	----	-.12	3
A- 723	.200	.149	.080	1.18	----	----	----	-.66	----	----	----	-.05	3
A- 724	.200	.197	.080	1.30	----	----	----	-.73	----	----	----	.01	3

See notes at end of table.

Table XIII-5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 5.00				B/D = 1.25					
A-700	.400	.001	.080	1.01	----	----	----	-.73	----	----	----	-.07	3
A-701	.400	.003	.080	1.01	----	----	----	-.78	----	----	----	-.05	3
A-702	.400	.013	.080	.93	----	----	----	-.66	----	----	----	-.03	3
A-703	.400	.024	.080	.92	----	----	----	-.63	----	----	----	-.03	3
A-704	.400	.036	.080	.85	----	----	----	-.55	----	----	----	-.01	3
A-725	.400	.059	.080	.79	----	----	----	-.42	----	----	----	-.01	3
A-726	.400	.099	.080	.75	----	----	----	-.50	----	----	----	.01	3
A-727	.400	.149	.080	.73	----	----	----	-.36	----	----	----	.04	3
A-728	.400	.197	.080	.75	----	----	----	-.31	----	----	----	.10	3
				Z_1/D = 3.00				B/D = 4.00					
A-838	.000	.001	.083	.90	.91	.01	1.1	-.43	-.33	.10	23.3	-.03	1
A-839	.000	.003	.083	.92	.90	-.02	-2.2	-.38	-.33	.05	13.2	-.06	1
A-840	.000	.013	.083	.82	.79	-.03	-3.7	-.30	-.33	-.03	-10.0	-.05	1
A-841	.000	.024	.083	.72	.69	-.03	-4.2	-.30	-.32	-.02	-6.7	-.01	1
A-842	.000	.036	.083	.63	.56	-.07	-11.1	-.28	-.31	-.03	-10.7	-.02	1
A-843	.000	.059	.083	.50	.47	-.03	-6.0	-.33	-.29	.04	12.1	-.10	1
A-844	.000	.099	.083	.48	.47	-.01	-2.1	-.31	-.29	.02	6.5	-.09	1,6
A-845	.000	.149	.083	.46	.47	.01	2.2	-.32	-.29	.03	9.4	-.10	1
A-846	.000	.197	.083	.47	.47	.00	.0	-.29	-.29	.00	.0	-.06	1
A-847	.025	.001	.083	.90	.90	.00	.0	-.48	-.34	.14	29.2	-.03	1
A-848	.025	.003	.083	.91	.89	-.02	-2.2	-.41	-.34	.07	17.1	-.03	1
A-849	.025	.013	.083	.82	.79	-.03	-3.7	-.32	-.33	-.01	-3.1	-.02	1
A-850	.025	.024	.083	.73	.68	-.05	-6.8	-.30	-.33	-.03	-10.0	.00	1
A-851	.025	.036	.083	.64	.56	-.08	-12.5	-.28	-.32	-.04	-14.3	-.01	1
A-852	.025	.059	.083	.50	.47	-.03	-6.0	-.34	-.30	.04	11.8	-.08	1
A-853	.025	.099	.083	.49	.47	-.02	-4.1	-.32	-.30	.02	6.2	-.07	1
A-854	.025	.149	.083	.48	.47	-.01	-2.1	-.32	-.30	.02	6.2	-.08	1
A-855	.025	.197	.083	.49	.47	-.02	-4.1	-.31	-.30	.01	3.2	-.05	1
A-856	.050	.001	.083	.88	.89	.01	1.1	-.46	-.35	.11	23.9	-.01	1
A-857	.050	.003	.083	.88	.88	.00	.0	-.45	-.35	.10	22.2	-.01	1
A-858	.050	.013	.083	.78	.78	.00	.0	-.28	-.34	-.06	-21.4	-.02	1
A-859	.050	.024	.083	.70	.68	-.02	-2.9	-.31	-.33	-.02	-6.5	-.02	1
A-860	.050	.036	.083	.61	.56	-.05	-8.2	-.32	-.32	.00	.0	-.03	1
A-861	.050	.059	.083	.49	.47	-.02	-4.1	-.36	-.31	.05	13.9	-.06	1
A-862	.050	.099	.083	.47	.47	.00	.0	-.37	-.31	.06	16.2	-.09	1
A-863	.050	.149	.083	.47	.47	.00	.0	-.30	-.31	-.01	-3.3	-.09	1
A-864	.050	.197	.083	.47	.47	.00	.0	-.31	-.31	.00	.0	-.06	1
A-865	.100	.001	.083	.86	.88	.02	2.3	-.46	-.36	.10	21.7	-.01	1
A-866	.100	.003	.083	.84	.86	.02	2.4	-.37	-.36	.01	2.7	-.02	1
A-867	.100	.013	.083	.76	.77	.01	1.3	-.27	-.35	-.08	-29.6	-.02	1
A-868	.100	.024	.083	.68	.67	-.01	-1.5	-.31	-.34	-.03	-9.7	-.01	1
A-869	.100	.036	.083	.61	.56	-.05	-8.2	-.31	-.33	-.02	-6.5	-.02	1
A-870	.100	.059	.083	.49	.47	-.02	-4.1	-.33	-.32	.01	3.0	-.08	1
A-871	.100	.099	.083	.48	.47	-.01	-2.1	-.33	-.32	.01	3.0	-.07	1
A-872	.100	.149	.083	.47	.47	.00	.0	-.33	-.32	.01	3.0	-.07	1
A-873	.100	.197	.083	.47	.47	.00	.0	-.33	-.32	.01	3.0	-.06	1
A-874	.200	.001	.083	.84	.84	.00	.0	-.41	-.38	.03	7.3	.00	1
A-875	.200	.003	.083	.83	.83	.00	.0	-.42	-.38	.04	9.5	-.02	1
A-876	.200	.013	.083	.82	.74	-.08	-9.8	-.31	-.37	-.06	-19.4	-.01	1
A-877	.200	.024	.083	.66	.65	-.01	-1.5	-.30	-.36	-.06	-20.0	.00	1
A-878	.200	.036	.083	.58	.55	-.03	-5.2	-.30	-.35	-.05	-16.7	-.01	1
A-879	.200	.059	.083	.48	.47	-.01	-2.1	-.31	-.33	-.02	-6.5	-.08	1
A-880	.200	.099	.083	.48	.47	-.01	-2.1	-.35	-.33	.02	5.7	-.06	1
A-881	.200	.149	.083	.48	.47	-.01	-2.1	-.32	-.33	-.01	-3.1	-.06	1
A-882	.200	.197	.083	.48	.47	-.01	-2.1	-.34	-.33	.01	2.9	-.04	1
A-883	.400	.001	.083	.75	.77	.02	2.7	-.35	-.40	-.05	-14.3	.03	1
A-884	.400	.003	.083	.76	.76	.00	.0	-.38	-.40	-.02	-5.3	.01	1
A-885	.400	.013	.083	.65	.69	.04	6.2	-.29	-.40	-.11	-37.9	.02	1
A-886	.400	.024	.083	.59	.62	.03	5.1	-.34	-.39	-.05	-14.7	.00	1
A-887	.400	.036	.083	.54	.53	-.01	-1.9	-.32	-.38	-.06	-18.8	-.01	1
A-888	.400	.059	.083	.50	.47	-.03	-6.0	-.38	-.36	.02	5.3	-.04	1
A-889	.400	.099	.083	.50	.47	-.03	-6.0	-.35	-.36	-.01	-2.9	-.04	1
A-890	.400	.149	.083	.49	.47	-.02	-4.1	-.30	-.36	-.06	-20.0	-.05	1
A-891	.400	.197	.083	.49	.47	-.02	-4.1	-.37	-.36	.01	2.7	-.03	1

See notes at end of table.

Table XIII–5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 3.00				B/D = 2.50					
A-1151	.000	.001	.083	.99	.96	-.03	-3.0	-.47	-.25	.22	46.8	-.09	1
A-1152	.000	.013	.083	.89	.86	-.03	-3.4	-.34	-.23	.11	32.4	-.02	1
A-1153	.000	.024	.083	.78	.78	.00	.0	-.27	-.22	.05	18.5	.00	1
A-1154	.000	.036	.083	.69	.68	-.01	-1.4	-.23	-.21	.02	8.7	-.01	1
A-1155	.000	.059	.083	.53	.50	-.03	-5.7	-.18	-.18	.00	.0	-.04	1
A-1156	.000	.099	.083	.49	.49	.00	.0	-.21	-.18	.03	14.3	-.05	1
A-1157	.000	.149	.083	.49	.49	.00	.0	-.24	-.18	.06	25.0	-.05	1
A-1158	.000	.197	.083	.49	.49	.00	.0	-.25	-.18	.07	28.0	-.03	1
A-1159	.050	.001	.083	.95	.93	-.02	-2.1	-.36	-.28	.08	22.2	-.08	1
A-1160	.050	.013	.083	.85	.84	-.01	-1.2	-.30	-.27	.03	10.0	-.02	1
A-1161	.050	.024	.083	.77	.76	-.01	-1.3	-.27	-.26	.01	3.7	.01	1
A-1162	.050	.036	.083	.68	.67	-.01	-1.5	-.23	-.24	-.01	-4.3	.00	1
A-1163	.050	.059	.083	.54	.50	-.04	-7.4	-.21	-.22	-.01	-4.8	-.02	1
A-1164	.050	.099	.083	.49	.48	-.01	-2.0	-.22	-.22	.00	.0	-.05	1
A-1165	.050	.149	.083	.48	.48	.00	.0	-.25	-.22	.03	12.0	-.05	1
A-1166	.050	.197	.083	.48	.48	.00	.0	-.26	-.22	.04	15.4	-.02	1
A-1167	.100	.001	.083	.93	.91	-.02	-2.2	-.42	-.31	.11	26.2	-.06	1
A-1168	.100	.013	.083	.83	.82	-.01	-1.2	-.31	-.29	.02	6.5	-.01	1
A-1169	.100	.024	.083	.73	.75	.02	2.7	-.27	-.28	-.01	-3.7	.00	1
A-1170	.100	.036	.083	.66	.66	.00	.0	-.25	-.27	-.02	-8.0	.00	1
A-1171	.100	.059	.083	.51	.50	-.01	-2.0	-.26	-.24	.02	7.7	-.04	1
A-1172	.100	.099	.083	.47	.48	.01	2.1	-.23	-.24	-.01	-4.3	-.05	1
A-1173	.100	.149	.083	.47	.48	.01	2.1	-.24	-.24	.00	.0	-.04	1
A-1174	.100	.197	.083	.45	.48	.03	6.7	-.25	-.24	.01	4.0	-.02	1
A-1175	.200	.001	.083	.86	.86	.00	.0	-.40	-.35	.05	12.5	-.04	1
A-1176	.200	.013	.083	.77	.78	.01	1.3	-.33	-.33	.00	.0	.01	1
A-1177	.200	.024	.083	.70	.71	.01	1.4	-.32	-.32	.00	.0	.02	1
A-1178	.200	.036	.083	.62	.63	.01	1.6	-.32	-.31	.01	3.1	.02	1
A-1179	.200	.059	.083	.49	.49	.00	.0	-.30	-.28	.02	6.7	-.04	1
A-1180	.200	.099	.083	.49	.47	-.02	-4.1	-.30	-.28	.02	6.7	-.05	1
A-1181	.200	.149	.083	.49	.47	-.02	-4.1	-.30	-.28	.02	6.7	-.03	1
A-1182	.200	.197	.083	.48	.47	-.01	-2.1	-.28	-.28	.00	.0	-.01	1
				Z_1/D = 3.00				B/D = 2.00					
A-784	.000	.001	.083	1.06	1.01	-.05	-4.7	-.50	-.28	.22	44.0	-.12	1
A-785	.000	.003	.083	1.03	1.00	-.03	-2.9	-.51	-.28	.23	45.1	-.11	1
A-786	.000	.013	.083	.93	.93	.00	.0	-.36	-.27	.09	25.0	-.05	1
A-787	.000	.024	.083	.82	.85	.03	3.7	-.31	-.25	.06	19.4	-.02	1
A-788	.000	.036	.083	.74	.77	.03	4.1	-.27	-.23	.04	14.8	-.01	1
A-789	.000	.059	.083	.65	.61	-.04	-6.2	-.20	-.20	.00	.0	-.03	1
A-790	.000	.099	.083	.49	.51	.02	4.1	-.22	-.20	.02	9.1	-.04	1
A-791	.000	.149	.083	.49	.51	.02	4.1	-.23	-.20	.03	13.0	-.04	1
A-792	.000	.197	.083	.50	.51	.01	2.0	-.24	-.20	.04	16.7	-.02	1
A-793	.025	.001	.083	.96	1.00	.04	4.2	-.52	-.31	.21	40.4	-.05	1
A-794	.025	.003	.083	.94	.99	.05	5.3	-.48	-.31	.17	35.4	-.06	1
A-795	.025	.013	.083	.89	.91	.02	2.2	-.34	-.29	.05	14.7	-.06	1
A-796	.025	.024	.083	.83	.84	.01	1.2	-.34	-.27	.07	20.6	-.02	1
A-797	.025	.036	.083	.74	.76	.02	2.7	-.30	-.26	.04	13.3	.00	1
A-798	.025	.059	.083	.66	.60	-.06	-9.1	-.24	-.22	.02	8.3	-.03	1
A-799	.025	.099	.083	.53	.51	-.02	-3.8	-.26	-.22	.04	15.4	-.03	1
A-800	.025	.149	.083	.50	.51	.01	2.0	-.26	-.22	.04	15.4	-.03	1
A-801	.025	.197	.083	.53	.51	-.02	-3.8	-.27	-.22	.05	18.5	.00	1
A-802	.050	.001	.083	.98	.98	.00	.0	-.50	-.33	.17	34.0	-.04	1
A-803	.050	.003	.083	.97	.97	.00	.0	-.47	-.32	.15	31.9	-.07	1
A-804	.050	.013	.083	.87	.90	.03	3.4	-.33	-.31	.02	6.1	-.05	1
A-805	.050	.024	.083	.80	.83	.03	3.7	-.31	-.29	.02	6.5	-.03	1
A-806	.050	.036	.083	.71	.75	.04	5.6	-.26	-.27	-.01	-3.8	-.02	1
A-807	.050	.059	.083	.61	.59	-.02	-3.3	-.20	-.24	-.04	-20.0	-.02	1
A-808	.050	.099	.083	.51	.50	-.01	-2.0	-.24	-.24	.00	.0	-.02	1
A-809	.050	.149	.083	.50	.50	.00	.0	-.23	-.24	-.01	-4.3	-.02	1
A-810	.050	.197	.083	.52	.50	-.02	-3.8	-.26	-.24	.02	7.7	.00	1

See notes at end of table.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 3.00				B/D = 2.00					
A-811	.100	.001	.083	.94	.95	.01	1.1	-.46	-.35	.11	23.9	-.05	1,7
A-812	.100	.003	.083	.94	.94	.00	.0	-.49	-.35	.14	28.6	-.04	1,7
A-813	.100	.013	.083	.87	.87	.00	.0	-.33	-.34	-.01	-3.0	-.04	1
A-814	.100	.024	.083	.79	.80	.01	1.3	-.36	-.32	.04	11.1	-.02	1
A-815	.100	.036	.083	.69	.73	.04	5.8	-.33	-.30	.03	9.1	-.03	1
A-816	.100	.059	.083	.62	.58	-.04	-6.5	-.26	-.27	-.01	-3.8	-.01	1
A-817	.100	.099	.083	.51	.50	-.01	-2.0	-.28	-.27	.01	3.6	-.02	1
A-818	.100	.149	.083	.51	.50	-.01	-2.0	-.28	-.27	.01	3.6	-.16	1
A-819	.100	.197	.083	.54	.50	-.04	-7.4	-.28	-.27	.01	3.6	-.01	1
A-820	.200	.001	.083	.88	.88	.00	.0	-.42	-.40	.02	4.8	.01	1,8
A-821	.200	.003	.083	.90	.87	-.03	-3.3	-.50	-.40	.10	20.0	-.04	1
A-822	.200	.013	.083	.81	.82	.01	1.2	-.40	-.39	.01	2.5	-.02	1
A-823	.200	.024	.083	.75	.76	.01	1.3	-.39	-.37	.02	5.1	-.02	1
A-824	.200	.036	.083	.67	.69	.02	3.0	-.38	-.35	.03	7.9	-.02	1
A-825	.200	.059	.083	.58	.56	-.02	-3.4	-.32	-.32	.00	.0	-.02	1
A-826	.200	.099	.083	.49	.49	.00	.0	-.36	-.31	.05	13.9	-.05	1
A-827	.200	.149	.083	.50	.49	-.01	-2.0	-.35	-.31	.04	11.4	-.03	1
A-828	.200	.197	.083	.53	.49	-.04	-7.5	-.39	-.31	.08	20.5	-.02	1
A-829	.400	.001	.083	.75	.75	.00	.0	-.48	-.48	.00	.0	.00	1
A-830	.400	.003	.083	.78	.74	-.04	-5.1	-.48	-.48	.00	.0	-.03	1
A-831	.400	.013	.083	.69	.70	.01	1.4	-.36	-.47	-.11	-30.6	-.02	1
A-832	.400	.024	.083	.63	.66	.03	4.8	-.36	-.45	-.09	-25.0	-.01	1
A-833	.400	.036	.083	.56	.61	.05	8.9	-.33	-.43	-.10	-30.3	-.02	1
A-834	.400	.059	.083	.50	.52	.02	4.0	-.35	-.40	-.05	-14.3	-.02	1
A-835	.400	.099	.083	.48	.46	-.02	-4.2	-.36	-.40	-.04	-11.1	-.05	1
A-836	.400	.149	.083	.48	.46	-.02	-4.2	-.35	-.40	-.05	-14.3	-.06	1
A-837	.400	.197	.083	.46	.46	.00	.0	-.42	-.40	.02	4.8	-.06	1
				Z_1/D = 3.00				B/D = 1.50					
A-892	.000	.001	.083	1.25	1.23	-.02	-1.6	-.64	-.47	.17	26.6	-.09	1
A-893	.000	.003	.083	1.25	1.22	-.03	-2.4	-.69	-.46	.23	33.3	-.10	1
A-894	.000	.013	.083	1.12	1.15	.03	2.7	-.58	-.44	.14	24.1	-.11	1
A-895	.000	.024	.083	1.07	1.09	.02	1.9	-.47	-.41	.06	12.8	-.07	1
A-896	.000	.036	.083	1.00	1.01	.01	1.0	-.41	-.38	.03	7.3	-.05	1
A-897	.000	.059	.083	.88	.87	-.01	-1.1	-.34	-.33	.01	2.9	-.02	1
A-898	.000	.099	.083	.76	.73	-.03	-3.9	-.30	-.33	-.03	-10.0	-.02	1
A-899	.000	.149	.083	.67	.73	.06	9.0	-.32	-.33	-.01	-3.1	-.02	1
A-900	.000	.197	.083	.79	.73	-.06	-7.6	-.29	-.33	-.04	-13.8	-.01	1
A-901	.025	.001	.083	1.23	1.20	-.03	-2.4	-.65	-.49	.16	24.6	-.10	1
A-902	.025	.003	.083	1.23	1.19	-.04	-3.3	-.64	-.48	.16	25.0	-.10	1
A-903	.025	.013	.083	1.12	1.13	.01	.9	-.54	-.46	.08	14.8	-.08	1
A-904	.025	.024	.083	1.04	1.07	.03	2.9	-.48	-.43	.05	10.4	-.07	1
A-905	.025	.036	.083	.93	.99	.06	6.5	-.42	-.40	.02	4.8	-.04	1
A-906	.025	.059	.083	.84	.86	.02	2.4	-.32	-.35	-.03	-9.4	-.04	1
A-907	.025	.099	.083	.70	.72	.02	2.9	-.25	-.35	-.10	-40.0	-.02	1
A-908	.025	.149	.083	.63	.72	.09	14.3	-.29	-.35	-.06	-20.7	-.02	1
A-909	.025	.197	.083	.68	.72	.04	5.9	-.27	-.35	-.08	-29.6	-.02	1
A-910	.050	.001	.083	1.10	1.17	.07	6.4	-.58	-.50	.08	13.8	-.11	1
A-911	.050	.003	.083	1.07	1.16	.09	8.4	-.63	-.50	.13	20.6	-.09	1
A-912	.050	.013	.083	.99	1.10	.11	11.1	-.49	-.47	.02	4.1	-.06	1
A-913	.050	.024	.083	.91	1.04	.13	14.3	-.46	-.45	.01	2.2	-.06	1
A-914	.050	.036	.083	.87	.97	.10	11.5	-.40	-.42	-.02	-5.0	-.04	1
A-915	.050	.059	.083	.82	.84	.02	2.4	-.34	-.36	-.02	-5.9	-.03	1
A-916	.050	.099	.083	.70	.71	.01	1.4	-.31	-.36	-.05	-16.1	-.02	1
A-917	.050	.149	.083	.66	.71	.05	7.6	-.32	-.36	-.04	-12.5	-.03	1
A-918	.050	.197	.083	.70	.71	.01	1.4	-.30	-.36	-.06	-20.0	.00	1

See notes at end of table.

Table XIII–5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 3.00				B/D = 1.25					
A-982	.200	.001	.083	1.44	----	----	----	-.77	----	----	----	-.11	3
A-983	.200	.003	.083	1.45	----	----	----	-.82	----	----	----	-.08	3
A-984	.200	.013	.083	1.36	----	----	----	-.71	----	----	----	-.07	3
A-985	.200	.024	.083	1.29	----	----	----	-.72	----	----	----	-.03	3
A-986	.200	.036	.083	1.21	----	----	----	-.70	----	----	----	.01	3
A-987	.200	.059	.083	1.14	----	----	----	-.65	----	----	----	.01	3
A-988	.200	.099	.083	1.10	----	----	----	-.56	----	----	----	-.10	3
A-989	.200	.149	.083	1.24	----	----	----	-.50	----	----	----	.01	3
A-990	.200	.197	.083	1.37	----	----	----	-.51	----	----	----	.05	3
A-991	.400	.001	.083	1.11	----	----	----	-.64	----	----	----	-.05	3
A-992	.400	.003	.083	1.09	----	----	----	-.73	----	----	----	-.04	3
A-993	.400	.013	.083	1.06	----	----	----	-.59	----	----	----	-.01	3
A-994	.400	.024	.083	1.01	----	----	----	-.65	----	----	----	.00	3
A-995	.400	.036	.083	.95	----	----	----	-.52	----	----	----	.01	3
A-996	.400	.059	.083	.89	----	----	----	-.46	----	----	----	.02	3
A-997	.400	.099	.083	.80	----	----	----	-.34	----	----	----	.03	3
A-998	.400	.149	.083	.84	----	----	----	-.32	----	----	----	.06	3
A-999	.400	.197	.083	.83	----	----	----	-.29	----	----	----	.05	3
				Z_1/D = 1.50				B/D = 4.00					
A-1000	.000	.001	.083	.93	.93	.00	.0	-.29	-.33	-.04	-13.8	-.06	1
A-1001	.000	.003	.083	.96	.92	-.04	-4.2	-.41	-.33	.08	19.5	-.04	1
A-1002	.000	.013	.083	.86	.81	-.05	-5.8	-.24	-.33	-.09	-37.5	-.02	1
A-1003	.000	.024	.083	.76	.71	-.05	-6.6	-.23	-.32	-.09	-39.1	.00	1
A-1004	.000	.036	.083	.67	.58	-.09	-13.4	-.23	-.31	-.08	-34.8	-.01	1
A-1005	.000	.059	.083	.53	.49	-.04	-7.5	-.28	-.29	-.01	-3.6	-.07	1
A-1006	.000	.099	.083	.50	.49	-.01	-2.0	-.25	-.29	-.04	-16.0	-.07	1
A-1007	.000	.149	.083	.50	.49	-.01	-2.0	-.28	-.29	-.01	-3.6	-.07	1
A-1008	.000	.197	.083	.50	.49	-.01	-2.0	-.23	-.29	-.06	-26.1	-.04	1
A-1009	.025	.001	.083	.93	.92	-.01	-1.1	-.34	-.34	.00	.0	-.08	1
A-1010	.025	.003	.083	.90	.91	.01	1.1	-.39	-.34	.05	12.8	-.06	1
A-1011	.025	.013	.083	.82	.81	-.01	-1.2	-.29	-.33	-.04	-13.8	-.02	1
A-1012	.025	.024	.083	.73	.70	-.03	-4.1	-.29	-.33	-.04	-13.8	.00	1
A-1013	.025	.036	.083	.62	.58	-.04	-6.5	-.24	-.32	-.08	-33.3	-.02	1
A-1014	.025	.059	.083	.49	.49	.00	.0	-.32	-.30	.02	6.2	-.08	1
A-1015	.025	.099	.083	.48	.49	.01	2.1	-.29	-.30	-.01	-3.4	-.07	1
A-1016	.025	.149	.083	.47	.49	.02	4.3	-.29	-.30	-.01	-3.4	-.08	1
A-1017	.025	.197	.083	.47	.49	.02	4.3	-.27	-.30	-.03	-11.1	-.05	1
A-1018	.050	.001	.083	.89	.91	.02	2.2	-.32	-.35	-.03	-9.4	-.06	1
A-1019	.050	.003	.083	.87	.90	.03	3.4	-.36	-.35	.01	2.8	-.04	1
A-1020	.050	.013	.083	.80	.80	.00	.0	-.22	-.34	-.12	-54.5	-.02	1
A-1021	.050	.024	.083	.72	.70	-.02	-2.8	-.26	-.33	-.07	-26.9	-.01	1
A-1022	.050	.036	.083	.63	.58	-.05	-7.9	-.26	-.32	-.06	-23.1	-.02	1
A-1023	.050	.059	.083	.48	.49	.01	2.1	-.29	-.31	-.02	-6.9	-.06	1
A-1024	.050	.099	.083	.49	.49	.00	.0	-.29	-.31	-.02	-6.9	-.06	1
A-1025	.050	.149	.083	.49	.49	.00	.0	-.28	-.31	-.03	-10.7	-.05	1
A-1026	.050	.197	.083	.50	.49	-.01	-2.0	-.30	-.31	-.01	-3.3	-.03	1
A-1027	.100	.001	.083	.90	.90	.00	.0	-.37	-.36	.01	2.7	-.02	1
A-1028	.100	.003	.083	.84	.88	.04	4.8	-.35	-.36	-.01	-2.9	.00	1
A-1029	.100	.013	.083	.74	.79	.05	6.8	-.26	-.35	-.09	-34.6	.02	1
A-1030	.100	.024	.083	.68	.69	.01	1.5	-.27	-.34	-.07	-25.9	.04	1
A-1031	.100	.036	.083	.59	.58	-.01	-1.7	-.26	-.33	-.07	-26.9	.00	1
A-1032	.100	.059	.083	.48	.49	.01	2.1	-.30	-.32	-.02	-6.7	-.04	1
A-1033	.100	.099	.083	.46	.49	.03	6.5	-.31	-.32	-.01	-3.2	-.04	1
A-1034	.100	.149	.083	.48	.49	.01	2.1	-.36	-.32	.04	11.1	-.04	1
A-1035	.100	.197	.083	.49	.49	.00	.0	-.32	-.32	.00	.0	-.02	1
A-1036	.200	.001	.083	.88	.86	-.02	-2.3	-.37	-.38	-.01	-2.7	.01	1
A-1037	.200	.013	.083	.79	.76	-.03	-3.8	-.32	-.37	-.05	-15.6	.04	1
A-1038	.200	.024	.083	.71	.67	-.04	-5.6	-.33	-.36	-.03	-9.1	.04	1
A-1039	.200	.036	.083	.62	.57	-.05	-8.1	-.30	-.35	-.05	-16.7	.01	1
A-1040	.200	.059	.083	.52	.49	-.03	-5.8	-.36	-.33	.03	8.3	-.04	1
A-1041	.200	.099	.083	.48	.49	.01	2.1	-.39	-.33	.06	15.4	-.06	1
A-1042	.200	.149	.083	.46	.49	.03	6.5	-.39	-.33	.06	15.4	-.06	1

See notes at end of table.

TABLE XIII-5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 3.00				B/D = 1.50					
A-919	.100	.001	.083	1.17	1.12	-.05	-4.3	-.62	-.53	.09	14.5	-.11	1
A-920	.100	.003	.083	1.15	1.11	-.04	-3.5	-.66	-.52	.14	21.2	-.09	1
A-921	.100	.013	.083	1.06	1.05	-.01	-.9	-.51	-.50	.01	2.0	-.07	1
A-922	.100	.024	.083	1.00	1.00	.00	.0	-.52	-.47	.05	9.6	-.07	1
A-923	.100	.036	.083	.86	.93	.07	8.1	-.43	-.44	-.01	-2.3	-.04	1
A-924	.100	.059	.083	.77	.81	.04	5.2	-.35	-.39	-.04	-11.4	-.02	1
A-925	.100	.099	.083	.63	.68	.05	7.9	-.31	-.39	-.08	-25.8	.00	1
A-926	.100	.149	.083	.58	.68	.10	17.2	-.27	-.39	-.12	-44.4	-.03	1
A-927	.100	.197	.083	.66	.68	.02	3.0	-.35	-.39	-.04	-11.4	.00	1
A-928	.200	.001	.083	1.08	1.01	-.07	-6.5	-.50	-.57	-.07	-14.0	-.15	1
A-929	.200	.003	.083	1.08	1.00	-.08	-7.4	-.60	-.56	.04	6.7	-.13	1
A-930	.200	.013	.083	.99	.95	-.04	-4.0	-.44	-.54	-.10	-22.7	-.12	1
A-931	.200	.024	.083	.87	.90	.03	3.4	-.44	-.51	-.07	-15.9	-.09	1
A-932	.200	.036	.083	.81	.85	.04	4.9	-.43	-.48	-.05	-11.6	-.10	1
A-933	.200	.059	.083	.76	.74	-.02	-2.6	-.42	-.43	-.01	-2.4	-.08	1
A-934	.200	.099	.083	.66	.63	-.03	-4.5	-.37	-.43	-.06	-16.2	-.03	1
A-935	.200	.149	.083	.60	.63	.03	5.0	-.31	-.43	-.12	-38.7	-.01	1
A-936	.200	.197	.083	.59	.63	.04	6.8	-.32	-.43	-.11	-34.4	-.01	1
A-937	.400	.001	.083	.90	.79	-.11	-12.2	-.59	-.63	-.04	-6.8	-.10	1
A-938	.400	.003	.083	.90	.79	-.11	-12.2	-.67	-.63	.04	6.0	-.09	1
A-939	.400	.013	.083	.81	.75	-.06	-7.4	-.56	-.61	-.05	-8.9	-.07	1
A-940	.400	.024	.083	.78	.72	-.06	-7.7	-.58	-.58	.00	.0	-.07	1
A-941	.400	.036	.083	.63	.68	.05	7.9	-.50	-.55	-.05	-10.0	-.03	1
A-942	.400	.059	.083	.59	.61	.02	3.4	-.47	-.50	-.03	-6.4	-.02	1
A-943	.400	.099	.083	.64	.54	-.10	-15.6	-.46	-.49	-.03	-6.5	-.01	1
A-944	.400	.149	.083	.61	.54	-.07	-11.5	-.43	-.49	-.06	-14.0	-.02	1
A-945	.400	.197	.083	.60	.54	-.06	-10.0	-.46	-.49	-.03	-6.5	-.02	1
				Z_1/D = 3.00				B/D = 1.25					
A-946	.000	.001	.083	1.79	----	----	----	-.91	----	----	----	-.10	3
A-947	.000	.003	.083	1.85	----	----	----	-.95	----	----	----	-.08	3
A-948	.000	.013	.083	1.75	----	----	----	-.80	----	----	----	-.11	3
A-949	.000	.024	.083	1.73	----	----	----	-.79	----	----	----	-.06	3
A-950	.000	.036	.083	1.69	----	----	----	-.66	----	----	----	-.03	3
A-951	.000	.059	.083	1.80	----	----	----	-.56	----	----	----	-.22	3
A-952	.000	.099	.083	1.97	----	----	----	-.69	----	----	----	-.43	3
A-953	.000	.149	.083	2.53	----	----	----	-.67	----	----	----	-.23	3
A-954	.000	.197	.083	3.50	----	----	----	-.71	----	----	----	-.01	3
A-955	.025	.001	.083	1.75	----	----	----	-.84	----	----	----	-.12	3
A-956	.025	.003	.083	1.80	----	----	----	-.89	----	----	----	-.12	3
A-957	.025	.013	.083	1.71	----	----	----	-.75	----	----	----	-.11	3
A-958	.025	.024	.083	1.68	----	----	----	-.72	----	----	----	-.05	3
A-959	.025	.036	.083	1.64	----	----	----	-.62	----	----	----	-.03	3
A-960	.025	.059	.083	1.66	----	----	----	-.62	----	----	----	-.12	3
A-961	.025	.099	.083	1.81	----	----	----	-.65	----	----	----	-.35	3
A-962	.025	.149	.083	2.24	----	----	----	-.64	----	----	----	-.14	3
A-963	.025	.197	.083	3.02	----	----	----	-.69	----	----	----	.00	3
A-964	.050	.001	.083	1.66	----	----	----	-.86	----	----	----	-.11	3
A-965	.050	.003	.083	1.72	----	----	----	-.88	----	----	----	-.08	3
A-966	.050	.013	.083	1.64	----	----	----	-.78	----	----	----	-.11	3
A-967	.050	.024	.083	1.58	----	----	----	-.74	----	----	----	-.05	3
A-968	.050	.036	.083	1.54	----	----	----	-.70	----	----	----	-.01	3
A-969	.050	.059	.083	1.55	----	----	----	-.59	----	----	----	-.04	3
A-970	.050	.099	.083	1.71	----	----	----	-.59	----	----	----	-.31	3
A-971	.050	.149	.083	2.12	----	----	----	-.64	----	----	----	-.14	3
A-972	.050	.197	.083	2.67	----	----	----	-.70	----	----	----	-.01	3
A-973	.100	.001	.083	1.56	----	----	----	-.78	----	----	----	-.12	3
A-974	.100	.003	.083	1.59	----	----	----	-.85	----	----	----	-.09	3
A-975	.100	.013	.083	1.51	----	----	----	-.70	----	----	----	-.08	3
A-976	.100	.024	.083	1.45	----	----	----	-.66	----	----	----	-.03	3
A-977	.100	.036	.083	1.37	----	----	----	-.66	----	----	----	.01	3
A-978	.100	.059	.083	1.35	----	----	----	-.60	----	----	----	-.03	3
A-979	.100	.099	.083	1.35	----	----	----	-.59	----	----	----	-.20	3
A-980	.100	.149	.083	1.63	----	----	----	-.60	----	----	----	-.05	3
A-981	.100	.197	.083	1.93	----	----	----	-.63	----	----	----	.01	3

See notes at end of table.

TABLE XIII–5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 1.50				B/D = 2.50					
A-1195	.000	.001	.083	.99	1.00	.01	1.0	-.39	-.25	.14	35.9	-.08	1
A-1196	.000	.013	.083	.90	.90	.00	.0	-.28	-.23	.05	17.9	-.02	1
A-1197	.000	.024	.083	.82	.82	.00	.0	-.23	-.22	.01	4.3	-.01	1
A-1198	.000	.036	.083	.73	.72	-.01	-1.4	-.21	-.21	.00	.0	.00	1
A-1199	.000	.059	.083	.45	.54	.09	20.0	-.18	-.18	.00	.0	-.03	1
A-1200	.000	.099	.083	.51	.53	.02	3.9	-.25	-.18	.07	28.0	-.06	1
A-1201	.000	.149	.083	.49	.53	.04	8.2	-.22	-.18	.04	18.2	-.05	1
A-1202	.000	.197	.083	.49	.53	.04	8.2	-.26	-.18	.08	30.8	-.03	1
A-1203	.050	.001	.083	.97	.97	.00	.0	-.39	-.28	.11	28.2	-.09	1
A-1204	.050	.013	.083	.87	.88	.01	1.1	-.29	-.27	.02	6.9	-.02	1
A-1205	.050	.024	.083	.80	.80	.00	.0	-.28	-.26	.02	7.1	-.01	1
A-1206	.050	.036	.083	.73	.71	-.02	-2.7	-.28	-.24	.04	14.3	-.01	1
A-1207	.050	.059	.083	.58	.54	-.04	-6.9	-.25	-.22	.03	12.0	-.04	1
A-1208	.050	.099	.083	.51	.52	.01	2.0	-.30	-.22	.08	26.7	-.16	1
A-1209	.050	.149	.083	.49	.52	.03	6.1	-.30	-.22	.08	26.7	-.05	1
A-1210	.050	.197	.083	.46	.52	.06	13.0	-.31	-.22	.09	29.0	-.07	1
A-1211	.100	.001	.083	.97	.95	-.02	-2.1	-.43	-.31	.12	27.9	-.16	1
A-1212	.100	.013	.083	.86	.86	.00	.0	-.30	-.29	.01	3.3	.03	1
A-1213	.100	.024	.083	.78	.79	.01	1.3	-.30	-.28	.02	6.7	-.02	1
A-1214	.100	.036	.083	.70	.70	.00	.0	-.28	-.27	.01	3.6	-.02	1
A-1215	.100	.059	.083	.57	.54	-.03	-5.3	-.26	-.24	.02	7.7	-.04	1
A-1216	.100	.099	.083	.51	.52	.01	2.0	-.35	-.24	.11	31.4	-.05	1
A-1217	.100	.149	.083	.49	.52	.03	6.1	-.31	-.24	.07	22.6	-.06	1
A-1218	.100	.197	.083	.51	.52	.01	2.0	-.31	-.24	.07	22.6	-.01	1
A-1219	.200	.001	.083	.92	.90	-.02	-2.2	-.46	-.35	.11	23.9	-.05	1
A-1220	.200	.013	.083	.83	.82	-.01	-1.2	-.35	-.33	.02	5.7	.00	1
A-1221	.200	.024	.083	.60	.75	.15	25.0	-.35	-.32	.03	8.6	.00	1
A-1222	.200	.036	.083	.68	.67	-.01	-1.5	-.35	-.31	.04	11.4	-.01	1
A-1223	.200	.059	.083	.56	.53	-.03	-5.4	-.33	-.28	.05	15.2	-.03	1
A-1224	.200	.099	.083	.53	.51	-.02	-3.8	-.40	-.28	.12	30.0	-.04	1
A-1225	.200	.149	.083	.52	.51	-.01	-1.9	-.39	-.28	.11	28.2	-.04	1
A-1226	.200	.197	.083	.50	.51	.01	2.0	-.38	-.28	.10	26.3	-.02	1
				Z_1/D = 1.50				B/D = 2.00					
A-1043	.000	.001	.083	1.08	1.07	-.01	-.9	-.47	-.28	.19	40.4	-.09	1
A-1044	.000	.013	.083	.94	.99	.05	5.3	-.40	-.27	.13	32.5	-.03	1
A-1045	.000	.024	.083	.88	.91	.03	3.4	-.34	-.25	.09	26.5	-.03	1
A-1046	.000	.036	.083	.78	.83	.05	6.4	-.33	-.23	.10	30.3	-.02	1
A-1047	.000	.059	.083	.71	.67	-.04	-5.6	-.20	-.20	.00	.0	-.02	1
A-1048	.000	.099	.083	.54	.57	.03	5.6	-.22	-.20	.02	9.1	-.02	1
A-1049	.000	.149	.083	.52	.57	.05	9.6	-.24	-.20	.04	16.7	-.02	1
A-1050	.000	.197	.083	.52	.57	.05	9.6	-.25	-.20	.05	20.0	.00	1
A-1051	.050	.001	.083	1.06	1.04	-.02	-1.9	-.47	-.33	.14	29.8	-.10	1
A-1052	.050	.013	.083	.95	.96	.01	1.1	-.38	-.31	.07	18.4	-.03	1
A-1053	.050	.024	.083	.87	.89	.02	2.3	-.36	-.29	.07	19.4	-.02	1
A-1054	.050	.036	.083	.79	.81	.02	2.5	-.32	-.27	.05	15.6	-.01	1
A-1055	.050	.059	.083	.70	.65	-.05	-7.1	-.26	-.24	.02	7.7	-.01	1
A-1056	.050	.099	.083	.55	.56	.01	1.8	-.24	-.24	.00	.0	-.02	1
A-1057	.050	.149	.083	.53	.56	.03	5.7	-.29	-.24	.05	17.2	-.02	1
A-1058	.050	.197	.083	.53	.56	.03	5.7	-.30	-.24	.06	20.0	.00	1
A-1059	.100	.001	.083	1.04	1.01	-.03	-2.9	-.44	-.35	.09	20.5	-.10	1
A-1060	.100	.013	.083	.95	.93	-.02	-2.1	-.36	-.34	.02	5.6	-.04	1
A-1061	.100	.024	.083	.84	.86	.02	2.4	-.37	-.32	.05	13.5	-.04	1
A-1062	.100	.036	.083	.77	.79	.02	2.6	-.34	-.30	.04	11.8	-.02	1
A-1063	.100	.059	.083	.68	.64	-.04	-5.9	-.32	-.27	.05	15.6	-.01	1
A-1064	.100	.099	.083	.54	.56	.02	3.7	-.26	-.27	-.01	-3.8	-.02	1
A-1065	.100	.149	.083	.53	.56	.03	5.7	-.28	-.27	.01	3.6	-.02	1
A-1066	.100	.197	.083	.54	.56	.02	3.7	-.32	-.27	.05	15.6	.00	1

See notes at end of table.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	Computed	Difference	Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 1.50				B/D = 2.00					
A-1067	.200	.001	.083	.94	.94	.00	.0	-.47	-.40	.07	14.9	-.09	1
A-1068	.200	.013	.083	.85	.88	.03	3.5	-.44	-.39	.05	11.4	-.04	1
A-1069	.200	.024	.083	.78	.82	.04	5.1	-.44	-.37	.07	15.9	-.04	1
A-1070	.200	.036	.083	.70	.75	.05	7.1	-.38	-.35	.03	7.9	-.04	1
A-1071	.200	.059	.083	.65	.62	-.03	-4.6	-.37	-.32	.05	13.5	-.03	1
A-1072	.200	.099	.083	.54	.55	.01	1.9	-.33	-.31	.02	6.1	-.02	1
A-1073	.200	.149	.083	.54	.55	.01	1.9	-.36	-.31	.05	13.9	-.02	1
A-1074	.200	.197	.083	.56	.55	-.01	-1.8	-.37	-.31	.06	16.2	.00	1
				Z_1/D = 1.50				B/D = 1.50					
A-1075	.000	.001	.083	1.40	1.35	-.05	-3.6	-.73	-.47	.26	35.6	-.17	1
A-1076	.000	.013	.083	1.29	1.27	-.02	-1.6	-.60	-.44	.16	26.7	-.10	1
A-1077	.000	.024	.083	1.18	1.21	.03	2.5	-.54	-.41	.13	24.1	-.07	1
A-1078	.000	.036	.083	1.10	1.13	.03	2.7	-.48	-.38	.10	20.8	-.05	1
A-1079	.000	.059	.083	.98	.99	.01	1.0	-.41	-.33	.08	19.5	-.04	1
A-1080	.000	.099	.083	.86	.85	-.01	-1.2	-.36	-.33	.03	8.3	-.02	1
A-1081	.000	.149	.083	.71	.85	.14	19.7	-.43	-.33	.10	23.3	-.03	1
A-1082	.000	.197	.083	.83	.85	.02	2.4	-.29	-.33	-.04	-13.8	-.08	1
A-1083	.050	.001	.083	1.33	1.29	-.04	-3.0	-.60	-.50	.10	16.7	-.11	1
A-1084	.050	.013	.083	1.23	1.22	-.01	-.8	-.54	-.47	.07	13.0	-.08	1
A-1085	.050	.024	.083	1.15	1.16	.01	.9	-.51	-.45	.06	11.8	-.05	1
A-1086	.050	.036	.083	1.08	1.09	.01	.9	-.47	-.42	.05	10.6	-.02	1
A-1087	.050	.059	.083	.97	.96	-.01	-1.0	-.36	-.36	.00	.0	-.02	1
A-1088	.050	.099	.083	.82	.83	.01	1.2	-.32	-.36	-.04	-12.5	.01	1
A-1089	.050	.149	.083	.72	.83	.11	15.3	-.32	-.36	-.04	-12.5	-.02	1
A-1090	.050	.197	.083	.81	.83	.02	2.5	-.32	-.36	-.04	-12.5	-.06	1
A-1091	.100	.001	.083	1.30	1.24	-.06	-4.6	-.63	-.53	.10	15.9	-.13	1
A-1092	.100	.013	.083	1.20	1.17	-.03	-2.5	-.53	-.50	.03	5.7	-.04	1
A-1093	.100	.024	.083	1.12	1.12	.00	.0	-.51	-.47	.04	7.8	-.04	1
A-1094	.100	.036	.083	1.04	1.05	.01	1.0	-.47	-.44	.03	6.4	-.02	1
A-1095	.100	.059	.083	.97	.93	-.04	-4.1	-.40	-.39	.01	2.5	-.02	1
A-1096	.100	.099	.083	.87	.80	-.07	-8.0	-.34	-.39	-.05	-14.7	.01	1
A-1097	.100	.149	.083	.76	.80	.04	5.3	-.32	-.39	-.07	-21.9	.01	1
A-1098	.100	.197	.083	.74	.80	.06	8.1	-.28	-.39	-.11	-39.3	-.04	1
A-1099	.200	.001	.083	1.24	1.13	-.11	-8.9	-.61	-.57	.04	6.6	-.10	1
A-1100	.200	.013	.083	1.15	1.07	-.08	-7.0	-.55	-.54	.01	1.8	-.06	1
A-1101	.200	.024	.083	1.08	1.02	-.06	-5.6	-.55	-.51	.04	7.3	-.04	1
A-1102	.200	.036	.083	1.00	.97	-.03	-3.0	-.50	-.48	.02	4.0	-.03	1
A-1103	.200	.059	.083	.94	.86	-.08	-8.5	-.45	-.43	.02	4.4	-.01	1
A-1104	.200	.099	.083	.84	.75	-.09	-10.7	-.35	-.43	-.08	-22.9	.02	1
A-1105	.200	.149	.083	.78	.75	-.03	-3.8	-.32	-.43	-.11	-34.4	.02	1
A-1106	.200	.197	.083	.78	.75	-.03	-3.8	-.30	-.43	-.13	-43.3	.02	1
				Z_1/D = 1.50				B/D = 1.25					
A-1139	.000	.001	.083	1.96	----	----	----	-1.19	----	----	----	-.06	3
A-1140	.000	.013	.083	1.80	----	----	----	-1.12	----	----	----	.05	3
A-1141	.000	.024	.083	1.74	----	----	----	-1.01	----	----	----	.09	3
A-1142	.000	.036	.083	1.68	----	----	----	-.87	----	----	----	.09	3
A-1143	.000	.059	.083	1.67	----	----	----	-.64	----	----	----	-.07	3
A-1144	.000	.099	.083	1.88	----	----	----	-.71	----	----	----	-.51	3
A-1145	.050	.001	.083	1.78	----	----	----	-1.11	----	----	----	.01	3
A-1146	.050	.013	.083	1.60	----	----	----	-1.05	----	----	----	.10	3
A-1147	.050	.024	.083	1.56	----	----	----	-1.01	----	----	----	.16	3
A-1148	.050	.036	.083	1.58	----	----	----	-.81	----	----	----	.08	3
A-1149	.050	.059	.083	1.58	----	----	----	-.61	----	----	----	-.08	3
A-1150	.050	.099	.083	1.75	----	----	----	-.70	----	----	----	-.45	3
A-1183	.100	.001	.083	1.67	----	----	----	-1.06	----	----	----	.01	3
A-1184	.100	.013	.083	1.63	----	----	----	-1.04	----	----	----	.09	3
A-1185	.100	.024	.083	1.54	----	----	----	-1.00	----	----	----	.15	3
A-1186	.100	.036	.083	1.54	----	----	----	-.95	----	----	----	.12	3
A-1187	.100	.059	.083	1.52	----	----	----	-.64	----	----	----	-.10	3
A-1188	.100	.099	.083	1.63	----	----	----	-.72	----	----	----	-.40	3

See notes at end of table.

TABLE XIII-5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 1.50				B/D = 1.25					
A-1189	.200	.001	.083	1.59	----	----	----	-.65	----	----	----	.00	3
A-1190	.200	.013	.083	1.54	----	----	----	-.82	----	----	----	.04	3
A-1191	.200	.024	.083	1.45	----	----	----	-.83	----	----	----	.10	3
A-1192	.200	.036	.083	1.36	----	----	----	-.77	----	----	----	.10	3
A-1193	.200	.059	.083	1.28	----	----	----	-.70	----	----	----	.10	3
A-1194	.200	.099	.083	1.38	----	----	----	-.68	----	----	----	-.44	3
				Z_1/D = 1.25				B/D = 2.00					
A-1227	.000	.001	.083	1.10	1.08	-.02	-1.8	-.46	-.28	.18	39.1	-.10	1
A-1228	.000	.013	.083	1.00	1.00	.00	.0	-.31	-.27	.04	12.9	.27	1
A-1229	.000	.024	.083	.92	.92	.00	.0	-.27	-.25	.02	7.4	.00	1
A-1230	.000	.036	.083	.82	.84	.02	2.4	-.23	-.23	.00	.0	.02	1
A-1231	.000	.059	.083	.71	.68	-.03	-4.2	-.20	-.20	.00	.0	.00	1
A-1232	.000	.099	.083	.55	.58	.03	5.5	-.21	-.20	.01	4.8	.00	1
A-1233	.000	.149	.083	.54	.58	.04	7.4	-.24	-.20	.04	16.7	.01	1
A-1234	.000	.197	.083	.54	.58	.04	7.4	-.28	-.20	.08	28.6	.02	1
A-1235	.050	.001	.083	1.09	1.05	-.04	-3.7	-.44	-.33	.11	25.0	-.07	1
A-1236	.050	.013	.083	.99	.97	-.02	-2.0	-.34	-.31	.03	8.8	-.01	1
A-1237	.050	.024	.083	.89	.90	.01	1.1	-.31	-.29	.02	6.5	.00	1
A-1238	.050	.036	.083	.82	.82	.00	.0	-.28	-.27	.01	3.6	.01	1
A-1239	.050	.059	.083	.69	.66	-.03	-4.3	-.22	-.24	-.02	-9.1	.01	1
A-1240	.050	.099	.083	.56	.57	.01	1.8	-.24	-.24	.00	.0	.01	1
A-1241	.050	.149	.083	.56	.57	.01	1.8	-.26	-.24	.02	7.7	.02	1
A-1242	.050	.197	.083	.56	.57	.01	1.8	-.26	-.24	.02	7.7	.03	1
A-1275	.100	.001	.083	1.03	1.02	-.01	-1.0	-.46	-.35	.11	23.9	-.07	1
A-1276	.100	.013	.083	.92	.94	.02	2.2	-.36	-.34	.02	5.6	-.02	1
A-1277	.100	.024	.083	.85	.87	.02	2.4	-.36	-.32	.04	11.1	-.01	1
A-1278	.100	.036	.083	.77	.80	.03	3.9	-.32	-.30	.02	6.2	.00	1
A-1279	.100	.059	.083	.67	.65	-.02	-3.0	-.28	-.27	.01	3.6	.00	1
A-1280	.100	.099	.083	.57	.57	.00	.0	-.29	-.27	.02	6.9	.01	1
A-1281	.100	.149	.083	.56	.57	.01	1.8	-.30	-.27	.03	10.0	.01	1
A-1282	.100	.197	.083	.56	.57	.01	1.8	-.30	-.27	.03	10.0	.02	1
A-1283	.200	.001	.083	.97	.95	-.02	-2.1	-.50	-.40	.10	20.0	-.07	1
A-1284	.200	.013	.083	.87	.89	.02	2.3	-.46	-.39	.07	15.2	-.03	1
A-1285	.200	.024	.083	.83	.83	.00	.0	-.44	-.37	.07	15.9	-.02	1
A-1286	.200	.036	.083	.75	.76	.01	1.3	-.39	-.35	.04	10.3	-.02	1
A-1287	.200	.059	.083	.65	.63	-.02	-3.1	-.34	-.32	.02	5.9	-.01	1
A-1288	.200	.099	.083	.56	.56	.00	.0	-.35	-.31	.04	11.4	-.01	1
A-1289	.200	.149	.083	.56	.56	.00	.0	-.36	-.31	.05	13.9	-.01	1
A-1290	.200	.197	.083	.56	.56	.00	.0	-.34	-.31	.03	8.8	.02	1
				Z_1/D = 1.25				B/D = 1.50					
A-1291	.000	.001	.083	1.41	1.37	-.04	-2.8	-.70	-.47	.23	32.9	-.16	1
A-1292	.000	.013	.083	1.24	1.29	.05	4.0	-.55	-.44	.11	20.0	-.08	1
A-1293	.000	.024	.083	1.23	1.23	.00	.0	-.55	-.41	.14	25.5	-.06	1
A-1294	.000	.036	.083	1.14	1.15	.01	.9	-.46	-.38	.08	17.4	-.04	1
A-1295	.000	.059	.083	1.04	1.01	-.03	-2.9	-.38	-.33	.05	13.2	-.04	1
A-1296	.000	.099	.083	.92	.87	-.05	-5.4	-.33	-.33	.00	.0	.00	1
A-1297	.000	.149	.083	.87	.87	.00	.0	-.29	-.33	-.04	-13.8	.02	1
A-1298	.000	.197	.083	.96	.87	-.09	-9.4	-.18	-.33	-.15	-83.3	.02	1
A-1299	.050	.001	.083	1.34	1.31	-.03	-2.2	-.68	-.50	.18	26.5	-.14	1
A-1300	.050	.013	.083	1.23	1.24	.01	.8	-.57	-.47	.10	17.5	-.07	1
A-1301	.050	.024	.083	1.15	1.18	.03	2.6	-.51	-.45	.06	11.8	-.06	1
A-1302	.050	.036	.083	1.07	1.11	.04	3.7	-.48	-.42	.06	12.5	-.03	1
A-1303	.050	.059	.083	1.00	.98	-.02	-2.0	-.38	-.36	.02	5.3	-.02	1
A-1304	.050	.099	.083	.93	.85	-.08	-8.6	-.32	-.36	-.04	-12.5	.01	1
A-1305	.050	.149	.083	.83	.85	.02	2.4	-.26	-.36	-.10	-38.5	.03	1
A-1306	.050	.197	.083	.92	.85	-.07	-7.6	-.19	-.36	-.17	-89.5	.04	1
A-1307	.100	.001	.083	1.28	1.26	-.02	-1.6	-.55	-.53	.02	3.6	-.11	1
A-1308	.100	.013	.083	1.20	1.19	-.01	-.8	-.56	-.50	.06	10.7	-.07	1
A-1309	.100	.024	.083	1.14	1.14	.00	.0	-.50	-.47	.03	6.0	-.05	1
A-1310	.100	.036	.083	1.06	1.07	.01	.9	-.46	-.44	.02	4.3	-.03	1
A-1311	.100	.059	.083	.97	.95	-.02	-2.1	-.38	-.39	-.01	-2.6	-.03	1
A-1312	.100	.099	.083	.85	.82	-.03	-3.5	-.29	-.39	-.10	-34.5	.01	1
A-1313	.100	.149	.083	.80	.82	.02	2.5	-.25	-.39	-.14	-56.0	.02	1
A-1314	.100	.197	.083	.92	.82	-.10	-10.9	-.20	-.39	-.19	-95.0	.04	1

See notes at end of table.

TABLE XIII-5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 1.25				B/D = 1.50					
A-1315	.200	.001	.083	1.26	1.15	-.11	-8.7	-.56	-.57	-.01	-1.8	-.10	1
A-1316	.200	.013	.083	1.20	1.09	-.11	-9.2	-.53	-.54	-.01	-1.9	-.03	1
A-1317	.200	.024	.083	1.06	1.04	-.02	-1.9	-.47	-.51	-.04	-8.5	-.05	1
A-1318	.200	.036	.083	1.00	.99	-.01	-1.0	-.45	-.48	-.03	-6.7	-.02	1
A-1319	.200	.059	.083	.94	.88	-.06	-6.4	-.40	-.43	-.03	-7.5	.01	1
A-1320	.200	.099	.083	.81	.77	-.04	-4.9	-.27	-.43	-.16	-59.3	.04	1
A-1321	.200	.149	.083	.76	.77	.01	1.3	-.22	-.43	-.21	-95.5	.05	1
A-1322	.200	.197	.083	.82	.77	-.05	-6.1	-.19	-.43	-.24	-126.3	.07	1
				Z_1/D = 1.00				B/D = 2.00					
A-1323	.000	.001	.083	1.13	----	----	----	-.33	----	----	----	-.09	3,8
A-1324	.000	.013	.083	1.02	----	----	----	-.12	----	----	----	-.05	3
A-1325	.000	.024	.083	.91	----	----	----	-.11	----	----	----	.05	3
A-1326	.000	.036	.083	.82	----	----	----	-.10	----	----	----	.05	3
A-1327	.000	.059	.083	.70	----	----	----	-.13	----	----	----	.03	3
A-1328	.000	.099	.083	.54	----	----	----	-.25	----	----	----	-.02	3
A-1329	.000	.149	.083	.56	----	----	----	-.24	----	----	----	-.02	3
A-1378	.050	.001	.083	1.05	----	----	----	-.34	----	----	----	-.01	3
A-1379	.050	.013	.083	.95	----	----	----	-.24	----	----	----	-.01	3
A-1380	.050	.024	.083	.88	----	----	----	-.22	----	----	----	-.01	3
A-1381	.050	.036	.083	.79	----	----	----	-.23	----	----	----	.00	3
A-1382	.050	.059	.083	.65	----	----	----	-.24	----	----	----	-.02	3
A-1383	.050	.099	.083	.53	----	----	----	-.27	----	----	----	-.03	3
A-1384	.050	.149	.083	.49	----	----	----	-.29	----	----	----	-.03	3
A-1363	.100	.001	.083	1.04	----	----	----	-.41	----	----	----	-.05	3
A-1364	.100	.013	.083	.92	----	----	----	-.32	----	----	----	.00	3
A-1365	.100	.024	.083	.85	----	----	----	-.30	----	----	----	.00	3
A-1366	.100	.036	.083	.77	----	----	----	-.28	----	----	----	.00	3
A-1367	.100	.059	.083	.64	----	----	----	-.29	----	----	----	-.02	3
A-1368	.100	.099	.083	.55	----	----	----	-.33	----	----	----	-.02	3
A-1369	.100	.149	.083	.56	----	----	----	-.31	----	----	----	-.06	3
A-1331	.200	.001	.083	1.00	----	----	----	-.31	----	----	----	-.01	3
A-1332	.200	.013	.083	.90	----	----	----	-.24	----	----	----	.03	3
A-1333	.200	.024	.083	.70	----	----	----	-.28	----	----	----	-.01	3
A-1334	.200	.036	.083	.65	----	----	----	-.32	----	----	----	-.01	3
A-1335	.200	.059	.083	.56	----	----	----	-.27	----	----	----	-.04	3
A-1336	.200	.099	.083	.54	----	----	----	-.37	----	----	----	-.03	3
A-1337	.200	.149	.083	.50	----	----	----	-.33	----	----	----	-.04	3
				Z_1/D = 1.00				B/D = 1.50					
A-1339	.000	.001	.083	1.34	----	----	----	-.59	----	----	----	-.15	3
A-1340	.000	.013	.083	1.24	----	----	----	-.45	----	----	----	-.03	3
A-1341	.000	.024	.083	1.20	----	----	----	-.40	----	----	----	-.02	3
A-1342	.000	.036	.083	1.11	----	----	----	-.33	----	----	----	.01	3
A-1343	.000	.059	.083	1.03	----	----	----	-.23	----	----	----	.01	3
A-1344	.000	.099	.083	.92	----	----	----	-.22	----	----	----	.11	3
A-1345	.000	.149	.083	.95	----	----	----	-.13	----	----	----	.05	3
A-1371	.050	.001	.083	1.33	----	----	----	-.58	----	----	----	-.12	3
A-1372	.050	.013	.083	1.24	----	----	----	-.40	----	----	----	-.02	3
A-1373	.050	.024	.083	1.18	----	----	----	-.41	----	----	----	-.01	3
A-1374	.050	.036	.083	1.10	----	----	----	-.41	----	----	----	-.03	3
A-1375	.050	.059	.083	.92	----	----	----	-.28	----	----	----	-.02	3
A-1376	.050	.099	.083	.82	----	----	----	-.20	----	----	----	-.02	3
A-1377	.050	.149	.083	.88	----	----	----	-.17	----	----	----	-.04	3
A-1355	.100	.001	.083	1.31	----	----	----	-.58	----	----	----	-.11	3
A-1356	.100	.013	.083	1.18	----	----	----	-.41	----	----	----	-.01	3
A-1357	.100	.024	.083	1.16	----	----	----	-.47	----	----	----	-.03	3
A-1358	.100	.036	.083	1.07	----	----	----	-.40	----	----	----	-.01	3
A-1359	.100	.059	.083	.95	----	----	----	-.28	----	----	----	.01	3
A-1360	.100	.099	.083	.86	----	----	----	-.22	----	----	----	.04	3
A-1361	.100	.149	.083	.86	----	----	----	-.19	----	----	----	.07	3

See notes at end of table.

Table XIII–5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 1.00				B/D = 1.50					
A-1347	.200	.001	.083	1.13	----	----	----	-.48	----	----	----	-.08	3
A-1348	.200	.013	.083	1.06	----	----	----	-.40	----	----	----	-.02	3
A-1349	.200	.024	.083	1.01	----	----	----	-.40	----	----	----	-.01	3
A-1350	.200	.036	.083	.99	----	----	----	-.37	----	----	----	.00	3
A-1351	.200	.059	.083	.90	----	----	----	-.33	----	----	----	.00	3
A-1352	.200	.099	.083	.77	----	----	----	-.24	----	----	----	.04	3
A-1353	.200	.149	.083	.80	----	----	----	-.22	----	----	----	.07	3
				Z_1/D = .75				B/D = 1.50					
A-1385	.000	.001	.083	1.28	----	----	----	-.50	----	----	----	-.15	3
A-1386	.000	.013	.083	1.25	----	----	----	-.45	----	----	----	-.08	3
A-1387	.000	.024	.083	1.16	----	----	----	-.40	----	----	----	-.10	3
A-1388	.000	.036	.083	1.09	----	----	----	-.38	----	----	----	-.09	3
A-1389	.000	.059	.083	.97	----	----	----	-.23	----	----	----	-.02	3
A-1390	.000	.099	.083	.84	----	----	----	-.21	----	----	----	.00	3
A-1391	.000	.149	.083	.90	----	----	----	-.17	----	----	----	.04	3
A-1392	.100	.001	.083	1.20	----	----	----	-.56	----	----	----	-.18	3
A-1393	.100	.013	.083	1.09	----	----	----	-.51	----	----	----	-.12	3
A-1394	.100	.024	.083	1.02	----	----	----	-.46	----	----	----	-.12	3
A-1395	.100	.036	.083	.96	----	----	----	-.43	----	----	----	-.09	3
A-1396	.100	.059	.083	.82	----	----	----	-.32	----	----	----	-.03	3
A-1397	.100	.099	.083	.76	----	----	----	-.26	----	----	----	.00	3
A-1398	.100	.149	.083	.78	----	----	----	-.20	----	----	----	.03	3
A-1399	.200	.001	.083	1.14	----	----	----	-.55	----	----	----	-.15	3
A-1400	.200	.013	.083	1.02	----	----	----	-.49	----	----	----	-.09	3
A-1401	.200	.024	.083	.96	----	----	----	-.48	----	----	----	-.08	3
A-1402	.200	.036	.083	.92	----	----	----	-.43	----	----	----	-.06	3
A-1403	.200	.059	.083	.81	----	----	----	-.36	----	----	----	-.02	3
A-1404	.200	.099	.083	.73	----	----	----	-.31	----	----	----	.02	3
A-1405	.200	.149	.083	.74	----	----	----	-.26	----	----	----	.02	3
				Z_1/D = .50				B/D = 2.00					
A-1406	.000	.001	.083	1.04	----	----	----	-.23	----	----	----	-.05	3
A-1407	.000	.013	.083	.92	----	----	----	-.14	----	----	----	.00	3
A-1408	.000	.024	.083	.83	----	----	----	-.12	----	----	----	.01	3
A-1409	.000	.036	.083	.71	----	----	----	-.09	----	----	----	.00	3
A-1410	.000	.059	.083	.60	----	----	----	-.11	----	----	----	-.02	3
A-1411	.000	.099	.083	.53	----	----	----	-.26	----	----	----	-.05	3
A-1412	.000	.149	.083	.52	----	----	----	-.24	----	----	----	-.04	3
A-1434	.050	.001	.083	1.01	----	----	----	-.29	----	----	----	-.05	3
A-1435	.050	.013	.083	.88	----	----	----	-.13	----	----	----	.03	3
A-1436	.050	.024	.083	.82	----	----	----	-.14	----	----	----	.03	3
A-1437	.050	.036	.083	.72	----	----	----	-.08	----	----	----	.01	3
A-1438	.050	.059	.083	.57	----	----	----	-.17	----	----	----	-.04	3
A-1439	.050	.099	.083	.52	----	----	----	-.29	----	----	----	-.04	3
A-1440	.050	.149	.083	.52	----	----	----	-.30	----	----	----	-.04	3
A-1441	.100	.001	.083	1.00	----	----	----	-.29	----	----	----	-.04	3
A-1442	.100	.013	.083	.88	----	----	----	-.11	----	----	----	.03	3
A-1443	.100	.024	.083	.80	----	----	----	-.11	----	----	----	.01	3
A-1444	.100	.036	.083	.70	----	----	----	-.10	----	----	----	.01	3
A-1445	.100	.059	.083	.57	----	----	----	-.19	----	----	----	-.03	3
A-1446	.100	.099	.083	.51	----	----	----	-.36	----	----	----	-.07	3
A-1447	.100	.149	.083	.52	----	----	----	-.35	----	----	----	-.05	3
A-1413	.200	.001	.083	.95	----	----	----	-.06	----	----	----	.06	3
A-1414	.200	.013	.083	.84	----	----	----	-.01	----	----	----	.09	3
A-1415	.200	.024	.083	.76	----	----	----	-.03	----	----	----	.05	3
A-1416	.200	.036	.083	.67	----	----	----	-.08	----	----	----	.03	3
A-1417	.200	.059	.083	.55	----	----	----	-.26	----	----	----	-.02	3
A-1418	.200	.099	.083	.52	----	----	----	-.34	----	----	----	-.05	3
A-1419	.200	.149	.083	.52	----	----	----	-.39	----	----	----	-.05	3

See notes at end of table.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = .50				8/D = 1.50					
A-1420	.000	.001	.083	1.14	----	----	----	-.30	----	----	----	-.08	3
A-1421	.000	.013	.083	1.04	----	----	----	-.24	----	----	----	-.02	3
A-1422	.000	.024	.083	.96	----	----	----	-.23	----	----	----	-.05	3
A-1423	.000	.036	.083	.87	----	----	----	-.23	----	----	----	-.06	3
A-1424	.000	.059	.083	.72	----	----	----	-.24	----	----	----	-.04	3
A-1425	.000	.099	.083	.66	----	----	----	-.22	----	----	----	.01	3
A-1426	.000	.149	.083	.69	----	----	----	-.23	----	----	----	.01	3
A-1448	.050	.001	.083	1.12	----	----	----	-.32	----	----	----	-.10	3
A-1449	.050	.013	.083	1.00	----	----	----	-.27	----	----	----	-.05	3
A-1450	.050	.024	.083	.92	----	----	----	-.28	----	----	----	-.06	3
A-1451	.050	.036	.083	.86	----	----	----	-.23	----	----	----	-.04	3
A-1452	.050	.059	.083	.71	----	----	----	-.23	----	----	----	-.01	3
A-1453	.050	.099	.083	.65	----	----	----	-.25	----	----	----	.02	3
A-1454	.050	.149	.083	.65	----	----	----	-.25	----	----	----	.00	3
A-1455	.100	.001	.083	1.07	----	----	----	-.31	----	----	----	-.08	3
A-1456	.100	.013	.083	.99	----	----	----	-.21	----	----	----	-.01	3
A-1457	.100	.024	.083	.92	----	----	----	-.24	----	----	----	-.02	3
A-1458	.100	.036	.083	.83	----	----	----	-.23	----	----	----	-.02	3
A-1459	.100	.059	.083	.68	----	----	----	-.25	----	----	----	-.01	3
A-1460	.100	.099	.083	.63	----	----	----	-.27	----	----	----	.01	3
A-1461	.100	.149	.083	.64	----	----	----	-.25	----	----	----	.02	3
A-1427	.200	.001	.083	1.03	----	----	----	-.33	----	----	----	-.06	3
A-1428	.200	.013	.083	.92	----	----	----	-.24	----	----	----	.00	3
A-1429	.200	.024	.083	.85	----	----	----	-.23	----	----	----	.00	3
A-1430	.200	.036	.083	.76	----	----	----	-.21	----	----	----	.02	3
A-1431	.200	.059	.083	.64	----	----	----	-.32	----	----	----	-.02	3
A-1432	.200	.099	.083	.59	----	----	----	-.32	----	----	----	.00	3
A-1433	.200	.149	.083	.59	----	----	----	-.31	----	----	----	-.01	3
				Z_1/D = .25				8/D = 2.00					
A-1462	.000	.001	.083	.97	----	----	----	-.38	----	----	----	-.08	3
A-1462	.000	.001	.083	1.02	----	----	----	-.38	----	----	----	-.09	3,4
A-1463	.000	.013	.083	.86	----	----	----	-.25	----	----	----	-.02	3
A-1463	.000	.013	.083	.91	----	----	----	-.28	----	----	----	-.02	3,4
A-1464	.000	.024	.083	.83	----	----	----	-.24	----	----	----	-.02	3
A-1464	.000	.024	.083	.84	----	----	----	-.26	----	----	----	-.03	3,4
A-1465	.000	.036	.083	.72	----	----	----	-.20	----	----	----	-.03	3
A-1466	.000	.059	.083	.56	----	----	----	-.14	----	----	----	-.07	3
A-1467	.000	.099	.083	.53	----	----	----	-.14	----	----	----	-.06	3
A-1468	.000	.149	.083	.51	----	----	----	-.18	----	----	----	-.05	3
A-1469	.200	.001	.083	.96	----	----	----	-.34	----	----	----	-.03	3
A-1470	.200	.013	.083	.84	----	----	----	-.22	----	----	----	.02	3
A-1471	.200	.024	.083	.75	----	----	----	-.23	----	----	----	.02	3
A-1472	.200	.036	.083	.68	----	----	----	-.20	----	----	----	.01	3
A-1473	.200	.059	.083	.53	----	----	----	-.18	----	----	----	-.04	3
A-1474	.200	.099	.083	.52	----	----	----	-.21	----	----	----	-.02	3
A-1475	.200	.149	.083	.52	----	----	----	-.27	----	----	----	-.02	3
				Z_1/D = .25				8/D = 1.50					
A-1476	.000	.001	.083	1.10	----	----	----	-.30	----	----	----	-.06	3
A-1477	.000	.013	.083	.96	----	----	----	-.19	----	----	----	.00	3
A-1478	.000	.024	.083	.88	----	----	----	-.14	----	----	----	.01	3
A-1479	.000	.036	.083	.78	----	----	----	-.11	----	----	----	.03	3
A-1480	.000	.059	.083	.62	----	----	----	-.14	----	----	----	-.03	3
A-1481	.000	.099	.083	.57	----	----	----	-.20	----	----	----	-.02	3
A-1482	.000	.149	.083	.53	----	----	----	-.19	----	----	----	-.02	3
A-1483	.200	.001	.083	.92	----	----	----	-.24	----	----	----	.01	3
A-1484	.200	.013	.083	.87	----	----	----	-.15	----	----	----	.04	3
A-1485	.200	.024	.083	.79	----	----	----	-.14	----	----	----	.02	3
A-1486	.200	.036	.083	.70	----	----	----	-.12	----	----	----	.02	3
A-1487	.200	.059	.083	.55	----	----	----	-.18	----	----	----	-.02	3

See notes at end of table.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 00.0				B/D = ∞					9
A- 459	.000	.001	----	1.02	.91	-.11	-10.8	-.42	-.42	.00	.0	.00	1
A-1243	.000	.001	----	1.07	.91	-.16	-15.0	-.47	-.42	.05	10.6	-.04	1,4
A- 453	.000	.003	----	1.01	.89	-.12	-11.9	-.45	-.41	.04	8.9	.07	1
A- 447	.000	.013	----	.92	.79	-.13	-14.1	-.46	-.37	.09	19.6	-.05	1
A-1244	.000	.013	----	.92	.79	-.13	-14.1	-.42	-.37	.05	11.9	-.02	1,4
A- 441	.000	.024	----	.81	.68	-.13	-16.0	-.38	-.34	.04	10.5	-.05	1
A-1245	.000	.024	----	.84	.68	-.16	-19.0	-.38	-.34	.04	10.5	-.03	1,4
A- 435	.000	.036	----	.69	.56	-.13	-18.8	-.31	-.29	.02	6.5	-.05	1
A-1246	.000	.036	----	.71	.56	-.15	-21.1	-.36	-.29	.07	19.4	-.04	1,4
A-1247	.000	.059	----	.55	.47	-.08	-14.5	-.22	-.21	.01	4.5	-.07	1
A-1248	.000	.099	----	.51	.47	-.04	-7.8	-.22	-.17	.05	22.7	-.07	1
A-1249	.000	.149	----	.48	.47	-.01	-2.1	-.16	-.17	-.01	-6.2	-.05	1
A-1250	.000	.197	----	.48	.47	-.01	-2.1	-.14	-.17	-.03	-21.4	-.02	1
A- 460	.025	.001	----	1.01	.90	-.11	-10.9	-.37	-.42	-.05	-13.5	.01	1
A- 454	.025	.003	----	.99	.89	-.10	-10.1	-.44	-.41	.03	6.8	.07	1
A- 448	.025	.013	----	.90	.78	-.12	-13.3	-.46	-.37	.09	19.6	-.02	1
A- 442	.025	.024	----	.80	.68	-.12	-15.0	-.38	-.34	.04	10.5	-.05	1
A- 436	.025	.036	----	.68	.56	-.12	-17.6	-.30	-.29	.01	3.3	-.04	1
A- 461	.050	.001	----	1.01	.89	-.12	-11.9	-.38	-.42	-.04	-10.5	.00	1
A- 465	.050	.001	----	1.00	.89	-.11	-11.0	-.47	-.42	.05	10.6	.00	1
A-1251	.050	.001	----	1.03	.89	-.14	-13.6	-.42	-.42	.00	.0	-.02	1,4
A- 455	.050	.003	----	1.00	.88	-.12	-12.0	-.43	-.41	.02	4.7	.08	1
A- 467	.050	.003	----	1.00	.88	-.12	-12.0	-.45	-.41	.04	8.9	.09	1
A- 449	.050	.013	----	.90	.78	-.12	-13.3	-.44	-.37	.07	15.9	-.01	1
A-1252	.050	.013	----	.92	.78	-.14	-15.2	-.40	-.37	.03	7.5	.03	1,4
A- 443	.050	.024	----	.78	.68	-.10	-12.8	-.34	-.34	.00	.0	-.03	1
A-1253	.050	.024	----	.81	.68	-.13	-16.0	-.35	-.34	.01	2.9	.01	1,4
A- 437	.050	.036	----	.66	.56	-.10	-15.2	-.29	-.29	.00	.0	-.01	1
A-1254	.050	.036	----	.67	.56	-.11	-16.4	-.34	-.29	.05	14.7	-.03	1,4
A-1255	.050	.059	----	.55	.47	-.08	-14.5	-.22	-.21	.01	4.5	-.04	1
A-1256	.050	.099	----	.50	.47	-.03	-6.0	-.19	-.17	.02	10.5	-.05	1
A-1257	.050	.149	----	.49	.47	-.02	-4.1	-.15	-.17	-.02	-13.3	-.04	1
A-1258	.050	.197	----	.48	.47	-.01	-2.1	-.16	-.17	-.01	-6.2	.00	1
A- 462	.100	.001	----	1.00	.87	-.13	-13.0	-.35	-.42	-.07	-20.0	.01	1
A- 466	.100	.001	----	.97	.87	-.10	-10.3	-.41	-.42	-.01	-2.4	.03	1
A-1259	.100	.001	----	1.00	.87	-.13	-13.0	-.42	-.42	.00	.0	.01	1,4
A- 456	.100	.003	----	.98	.86	-.12	-12.2	-.42	-.41	.01	2.4	.09	1
A- 468	.100	.003	----	.97	.86	-.11	-11.3	-.43	-.41	.02	4.7	.10	1
A- 450	.100	.013	----	.88	.77	-.11	-12.5	-.41	-.37	.04	9.8	.02	1
A-1260	.100	.013	----	.91	.77	-.14	-15.4	-.35	-.37	-.02	-5.7	.05	1,4
A- 444	.100	.024	----	.75	.67	-.08	-10.7	-.33	-.34	-.01	-3.0	.00	1
A-1261	.100	.024	----	.78	.67	-.11	-14.1	-.35	-.34	.01	2.9	.01	1,4
A- 438	.100	.036	----	.64	.55	-.09	-14.1	-.31	-.29	.02	6.5	-.01	1
A-1262	.100	.036	----	.66	.55	-.11	-16.7	-.32	-.29	.03	9.4	-.01	1,4
A-1263	.100	.059	----	.54	.47	-.07	-13.0	-.23	-.21	.02	8.7	-.05	1
A-1264	.100	.099	----	.50	.47	-.03	-6.0	-.17	-.17	.00	.0	-.03	1
A-1265	.100	.149	----	.49	.47	-.02	-4.1	-.17	-.17	.00	.0	-.03	1
A-1266	.100	.197	----	.48	.47	-.01	-2.1	-.15	-.17	-.02	-13.3	.00	1
A- 463	.200	.001	----	.94	.84	-.10	-10.6	-.32	-.42	-.10	-31.2	.04	1
A-1267	.200	.001	----	.96	.84	-.12	-12.5	-.42	-.42	.00	.0	.00	1,4
A- 457	.200	.003	----	.93	.83	-.10	-10.8	-.40	-.41	-.01	-2.5	.11	1
A- 451	.200	.013	----	.84	.74	-.10	-11.9	-.26	-.37	-.11	-42.3	.06	1
A-1268	.200	.013	----	.88	.74	-.14	-15.9	-.27	-.37	-.10	-37.0	.08	1,4
A- 445	.200	.024	----	.74	.65	-.09	-12.2	-.28	-.34	-.06	-21.4	.04	1
A-1269	.200	.024	----	.77	.65	-.12	-15.6	-.32	-.34	-.02	-6.2	.04	1,4
A- 439	.200	.036	----	.62	.54	-.08	-12.9	-.29	-.29	.00	.0	.01	1
A-1270	.200	.036	----	.66	.54	-.12	-18.2	-.27	-.29	-.02	-7.4	.01	1,4
A-1271	.200	.059	----	.53	.47	-.06	-11.3	-.21	-.21	.00	.0	-.04	1

See notes at end of table.

TABLE XIII-5.—Continued.

Series	S	t_p/D	t_c/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
							Percent				Percent		
				Z_1/D = 00.0				B/D = ∞					9
A-1272	.200	.099	----	.50	.47	-.03	-6.0	-.18	-.17	.01	5.6	-.01	1
A-1273	.200	.149	----	.49	.47	-.02	-4.1	-.19	-.17	.02	10.5	-.01	1
A-1274	.200	.197	----	.48	.47	-.01	-2.1	-.18	-.17	.01	5.6	.02	1
A-464	.400	.001	----	.91	.77	-.14	-15.4	-.30	-.42	-.12	-40.0	.07	1
A-458	.400	.003	----	.90	.76	-.14	-15.6	-.36	-.41	-.05	-13.9	.17	1
A-452	.400	.013	----	.80	.69	-.11	-13.7	-.25	-.37	-.12	-48.0	.08	1
A-446	.400	.024	----	.70	.61	-.09	-12.9	-.28	-.34	-.06	-21.4	.06	1
A-440	.400	.036	----	.60	.53	-.07	-11.7	-.29	-.29	.00	.0	.04	1

[1] Drop inlet dimensions meet the recommended criteria and its performance is satisfactory.

[2] Hydraulic gradeline was poor; this series was repeated to check the consistency of the results. (See next series entry.)

[3] Drop inlet dimensions do not meet the recommended criteria.

[4] The previously listed series was repeated to check the consistency of the results.

[5] Leaks were observed; this series was repeated. (See next series entry.)

[6] Invert of the hood was discovered to be above drop inlet bottom.

[7] Invert of the hood was about one-sixteenth inch above the drop inlet floor.

[8] No antivortex device was used.

[9] Hood inlet invert placed at the downstream edge of a berm; dam face slopes 1 on 3.

Table XIII–6.—*Summary of air test results for circular drop inlet—reentrant hood*

Series	S	t_p/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
						Percent				Percent		
			Z_1/D = 4.00				B/D = 2.00					
A-1524	.00	.001	.98	1.05	.07	7.1	-.23	-.34	-.11	-47.8	-.13	1
A-1525	.00	.013	.89	.98	.09	10.1	-.26	-.31	-.05	-19.2	-.05	1
A-1526	.00	.024	.80	.90	.10	12.5	-.21	-.29	-.08	-38.1	-.05	1
A-1527	.00	.036	.72	.82	.10	13.9	-.19	-.27	-.08	-42.1	-.03	1
A-1528	.00	.059	.63	.67	.04	6.3	-.16	-.23	-.07	-43.8	-.05	1
A-1529	.20	.001	.90	.90	.00	.0	-.37	-.45	-.08	-21.6	-.07	1
A-1530	.20	.013	.79	.84	.05	6.3	-.30	-.42	-.12	-40.0	-.01	1
A-1531	.20	.024	.72	.78	.06	8.3	-.32	-.41	-.09	-28.1	-.02	1
A-1532	.20	.036	.66	.72	.06	9.1	-.30	-.38	-.08	-26.7	-.01	1
A-1533	.20	.059	.59	.60	.01	1.7	-.24	-.34	-.10	-41.7	-.03	1
			Z_1/D = 4.00				B/D = 1.50					
A-1534	.00	.001	1.24	----	----	----	-.54	----	----	----	-.15	2
A-1535	.00	.013	1.16	----	----	----	-.59	----	----	----	-.08	2
A-1536	.00	.024	1.11	----	----	----	-.60	----	----	----	-.05	2
A-1537	.00	.036	1.07	----	----	----	-.55	----	----	----	-.01	2
A-1537	.00	.036	.98	----	----	----	-.52	----	----	----	-.05	2, 3
A-1538	.00	.059	.94	----	----	----	-.43	----	----	----	.00	2
A-1539	.20	.001	.91	----	----	----	-.50	----	----	----	-.02	2
A-1540	.20	.013	.88	----	----	----	-.56	----	----	----	.02	2
A-1541	.20	.024	.84	----	----	----	-.54	----	----	----	.02	2
A-1541	.20	.024	.84	----	----	----	-.55	----	----	----	.00	2, 3
A-1542	.20	.036	.77	----	----	----	-.48	----	----	----	.05	2
A-1542	.20	.036	.82	----	----	----	-.55	----	----	----	.04	2, 3
A-1543	.20	.059	.75	----	----	----	-.43	----	----	----	.05	2
			Z_1/D = 2.00				B/D = 3.83					
A-1514	.00	.001	.91	.94	.03	3.3	-.45	-.28	.17	37.8	-.08	1
A-1515	.00	.013	.80	.83	.03	3.7	-.26	-.27	-.01	-3.8	-.02	1
A-1516	.00	.024	.72	.73	.01	1.4	-.28	-.26	.02	7.1	-.01	1
A-1517	.00	.036	.63	.62	-.01	-1.6	-.28	-.25	.03	10.7	-.02	1
A-1518	.00	.059	.49	.49	.00	.0	-.24	-.24	.00	.0	-.06	1
A-1519	.20	.001	.79	.86	.07	8.9	-.36	-.35	.01	2.8	-.03	1
A-1520	.20	.013	.71	.77	.06	8.5	-.34	-.34	.00	.0	.02	1
A-1521	.20	.024	.64	.69	.05	7.8	-.33	-.33	.00	.0	.01	1
A-1522	.20	.036	.57	.59	.02	3.5	-.32	-.32	.00	.0	.01	1
A-1523	.20	.059	.49	.49	.00	.0	-.35	-.30	.05	14.3	-.03	1
			Z_1/D = 2.00				B/D = 2.00					
A-1544	.00	.001	1.18	1.12	-.06	-5.1	-.24	-.34	-.10	-41.7	-.02	1
A-1545	.00	.013	1.03	1.04	.01	1.0	-.18	-.31	-.13	-72.2	-.01	1
A-1546	.00	.024	.96	.97	.01	1.0	-.18	-.29	-.11	-61.1	.00	1
A-1547	.00	.036	.90	.89	-.01	-1.1	-.15	-.27	-.12	-80.0	.00	1
A-1548	.00	.059	.81	.74	-.07	-8.6	-.21	-.23	-.02	-9.5	-.04	1
A-1548	.00	.059	.80	.74	-.06	-7.5	-.16	-.23	-.07	-43.8	-.03	1, 3

See notes at end of table.

TABLE XIII-6.—Continued.

Series	S	t_p/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
						Percent				Percent		
			Z_1/D = 2.00				B/D = 2.00					
A-1549	.20	.001	.92	.96	.04	4.3	-.41	-.45	-.04	-9.8	.02	1
A-1550	.20	.013	.84	.90	.06	7.1	-.34	-.42	-.08	-23.5	.03	1
A-1551	.20	.024	.80	.85	.05	6.3	-.38	-.41	-.03	-7.9	.00	1
A-1552	.20	.036	.79	.78	-.01	-1.3	-.33	-.38	-.05	-15.2	.02	1
A-1553	.20	.059	.74	.67	-.07	-9.5	-.29	-.34	-.05	-17.2	.01	1
			Z_1/D = 2.00				B/D = 1.50					
A-1554	.00	.001	1.42	----	----	----	-.69	----	----	----	-.11	2
A-1555	.00	.013	1.30	----	----	----	-.62	----	----	----	-.07	2
A-1556	.00	.024	1.20	----	----	----	-.65	----	----	----	.03	2
A-1557	.00	.036	1.12	----	----	----	-.63	----	----	----	.01	2
A-1558	.00	.059	1.03	----	----	----	-.43	----	----	----	.06	2
A-1559	.20	.001	1.18	----	----	----	-.49	----	----	----	.00	2
A-1560	.20	.013	1.14	----	----	----	-.58	----	----	----	.04	2
A-1561	.20	.024	1.08	----	----	----	-.54	----	----	----	.07	2
A-1562	.20	.036	1.02	----	----	----	-.45	----	----	----	.15	2
A-1563	.20	.059	.94	----	----	----	-.36	----	----	----	.12	2
			Z_1/D = 1.50				B/D = 2.00					
A-1564	.00	.001	1.17	1.15	-.02	-1.7	-.26	-.34	-.08	-30.8	-.06	1
A-1565	.00	.013	1.05	1.07	.02	1.9	-.20	-.31	-.11	-55.0	.00	1
A-1566	.00	.024	.98	.99	.01	1.0	-.19	-.29	-.10	-52.6	-.02	1
A-1567	.00	.036	.91	.91	.00	.0	-.20	-.27	-.07	-35.0	.00	1
A-1568	.00	.059	.82	.76	-.06	-7.3	-.21	-.23	-.02	-9.5	-.04	1
A-1569	.20	.001	.97	.99	.02	2.1	-.31	-.45	-.14	-45.2	-.01	1
A-1570	.20	.013	.89	.93	.04	4.5	-.39	-.42	-.03	-7.7	.01	1
A-1571	.20	.024	.84	.87	.03	3.6	-.35	-.41	-.06	-17.1	.00	1
A-1572	.20	.036	.79	.81	.02	2.5	-.36	-.38	-.02	-5.6	.01	1
A-1573	.20	.059	.73	.69	-.04	-5.5	-.30	-.34	-.04	-13.3	.01	1
			Z_1/D = 1.50				B/D = 1.50					
A-1574	.00	.001	1.48	----	----	----	-.68	----	----	----	-.14	2
A-1575	.00	.013	1.38	----	----	----	-.75	----	----	----	-.04	2
A-1576	.00	.024	1.28	----	----	----	-.69	----	----	----	-.02	2
A-1577	.00	.036	1.24	----	----	----	-.72	----	----	----	-.06	2
A-1578	.00	.059	1.11	----	----	----	-.59	----	----	----	.10	2
A-1579	.20	.001	1.41	----	----	----	-.61	----	----	----	.02	2
A-1580	.20	.013	1.30	----	----	----	-.54	----	----	----	.14	2
A-1581	.20	.024	1.24	----	----	----	-.46	----	----	----	.14	2
A-1582	.20	.036	1.16	----	----	----	-.35	----	----	----	.18	2
A-1583	.20	.059	1.08	----	----	----	-.25	----	----	----	.15	2

[1]Drop inlet dimensions meet the recommended criteria and its performance is satisfactory.

[2]Drop inlet dimensions do not meet the recommended criteria.

[3]The previously listed series was repeated to check the consistency of the results.

TABLE XIII–7.—*Summary of water test results for square drop inlet—reentrant hood*
$t_p/D = 0.056, S = 0.20$

Series	Z_1/D	B/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
						Percent				Percent		
w-143	4.00	6.00	.56	.47	-.09	-16.1	-.40	-.34	.06	14.4	.18	1
w-142	4.00	4.00	.52	.47	-.05	-9.6	-.38	-.34	.04	11.5	.13	1
w-111	4.00	2.00	.50	.57	.07	14.0	-.35	-.32	.03	8.6	.17	1
w-110	4.00	1.50	.69	.74	.05	7.2	-.45	-.44	.01	1.6	.27	1
w-109	4.00	1.25	1.06	----	----	-----	-.52	----	----	-----	-.16	2
w-108	4.00	1.11	1.61	----	----	-----	-.74	----	----	-----	-.77	2
w-107	4.00	1.00	3.14	----	----	-----	-1.15	----	----	-----	-1.43	2,3
w-144	2.00	6.00	.57	.48	-.09	-15.8	-.40	-.34	.06	15.0	.15	1
w-145	2.00	4.00	.56	.49	-.07	-12.5	-.43	-.34	.09	21.5	.11	1
w-116	2.00	2.00	.61	.62	.01	1.6	-.40	-.32	.08	20.2	.29	1
w-115	2.00	1.50	.86	.84	-.02	-2.3	-.42	-.44	-.02	-5.8	.58	1
w-114	2.00	1.25	1.22	----	----	-----	-.63	----	----	-----	-.44	2,3
w-112	2.00	1.11	1.73	----	----	-----	-.91	----	----	-----	-1.21	2,3
w-113	2.00	1.00	3.22	----	----	-----	-1.29	----	----	-----	-1.83	2,3
w-147	1.50	6.00	.56	.48	-.08	-14.3	-.41	-.34	.07	16.7	.16	1
w-146	1.50	4.00	.59	.49	-.10	-16.9	-.44	-.34	.10	22.0	.13	1
w-121	1.50	2.00	.64	.64	.00	.0	-.41	-.32	.09	22.3	.19	1
w-120	1.50	1.50	.90	.88	-.02	-2.2	-.44	-.44	.00	.0	.36	1
w-119	1.50	1.25	1.32	----	----	-----	-.49	----	----	-----	-.42	2,3
w-118	1.50	1.11	1.83	----	----	-----	-1.02	----	----	-----	-1.44	2,3
w-117	1.50	1.00	3.49	----	----	-----	-1.44	----	----	-----	-2.02	2,3
w-149	1.25	6.00	.58	.49	-.09	-15.5	-.42	-.34	.08	18.5	.19	1
w-148	1.25	4.00	.56	.50	-.06	-10.7	-.42	-.34	.08	19.0	.09	1
w-126	1.25	2.00	.71	.65	-.06	-8.5	-.45	-.32	.13	29.0	.15	1
w-123	1.25	1.50	.99	.90	-.09	-9.1	-.42	-.44	-.02	-4.3	.38	1
w-125	1.25	1.25	1.44	----	----	-----	-.40	----	----	-----	-.07	2,3
w-124	1.25	1.11	2.12	----	----	-----	-.82	----	----	-----	-1.11	2,3
w-122	1.25	1.00	3.82	----	----	-----	-1.24	----	----	-----	-2.02	2,3
w-151	1.00	6.00	.58	.47	-.11	-19.0	-.37	-.32	.05	13.0	.19	1
w-150	1.00	4.00	.57	.50	-.07	-12.3	-.36	-.32	.04	10.6	.10	1
w-131	1.00	2.00	.64	----	----	-----	-.40	----	----	-----	.12	2,3
w-130	1.00	1.50	.88	----	----	-----	-.38	----	----	-----	.18	2,3
w-129	1.00	1.25	1.37	----	----	-----	-.35	----	----	-----	.34	2,3
w-128	1.00	1.11	2.41	----	----	-----	2.08	----	----	-----	-.19	2,3,4
w-127	1.00	1.00	4.74	----	----	-----	-.06	----	----	-----	.26	2,3
w-153	.75	6.00	.58	.49	-.09	-15.5	-.36	-.29	.07	18.8	.16	1
w-152	.75	4.00	.56	.49	-.07	-12.5	-.40	-.29	.11	27.7	.11	1
w-136	.75	2.00	.63	----	----	-----	-.39	----	----	-----	.18	2,3
w-135	.75	1.50	.79	----	----	-----	-.36	----	----	-----	.19	2,3
w-134	.75	1.25	1.17	----	----	-----	-.27	----	----	-----	.25	2,3
w-133	.75	1.11	1.61	----	----	-----	-.20	----	----	-----	.08	2,5
w-132	.75	1.00	2.64	----	----	-----	.05	----	----	-----	-.09	2,3
w-154	.50	6.00	.62	.48	-.14	-22.6	-.36	-.27	.09	23.9	.21	1
w-155	.50	4.00	.56	.49	-.07	-12.5	-.39	-.27	.12	30.1	.11	1
w-139	.50	2.00	.59	----	----	-----	-.35	----	----	-----	.19	2,5
w-138	.50	1.50	.66	----	----	-----	-.35	----	----	-----	.21	2,3
w-137	.50	1.25	.78	----	----	-----	-.31	----	----	-----	.20	2,3
w-141	.50	1.11	.73	----	----	-----	-.15	----	----	-----	.09	2,6
w-140	.50	1.00	.89	----	----	-----	-.08	----	----	-----	.00	2,6
w-156	.25	6.00	.60	.48	-.12	-20.0	-.33	-.25	.08	23.8	.19	1
w-157	.25	4.00	.57	.49	-.08	-14.0	-.40	-.25	.15	38.0	.15	1
w-158	.25	2.00	.58	----	----	-----	-.26	----	----	-----	.24	2
w-159	.25	1.50	.57	----	----	-----	-.19	----	----	-----	.24	2
w-160	.25	1.25	.60	----	----	-----	-.25	----	----	-----	.21	2,3
w-161	.25	1.11	.64	----	----	-----	-.24	----	----	-----	.26	2,3
w-162	.25	1.00	.55	----	----	-----	-.14	----	----	-----	.21	2,5

[1] Drop inlet dimensions meet the recommended criteria and its performance is satisfactory.
[2] Drop inlet dimensions do not meet the recommended criteria.
[3] Drop inlet performance is poor.
[4] No explanation is available for the high value of h_n/h_{vp} at D/2 invert.
[5] Drop inlet performance is borderline between satisfactory and poor.
[6] Drop inlet performance is satisfactory but the headpool surface level fluctuates slightly.

Table XIII–8.—*Summary of water test results for circular drop inlet—reentrant hood*

$t_p/D = 0.056, S = 0.20$

Series	Z_i/D	B/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
						Percent				Percent		
W-168	4.00	5.11	.58	.47	-.11	-19.0	-.55	-.34	.21	38.6	.15	1
W-167	4.00	3.77	.63	.47	-.16	-25.4	-.56	-.30	.26	46.0	.14	1
W-163	4.00	1.98	.60	.62	.02	3.3	-.43	-.35	.08	18.4	.19	1
W-166	4.00	1.55	.81	----	----	-----	-.68	----	----	-----	.23	2
W-165	4.00	1.32	1.17	----	----	-----	-.64	----	----	-----	-.31	2
W-172	2.00	5.11	.60	.48	-.12	-20.0	-.55	-.34	.21	37.7	.17	1
W-171	2.00	3.77	.60	.49	-.11	-18.3	-.56	-.30	.26	46.0	.14	1
W-173	2.00	1.98	.73	.69	-.04	-5.5	-.39	-.35	.04	10.9	.27	1
W-170	2.00	1.55	1.08	----	----	-----	-.19	----	----	-----	.60	2
W-169	2.00	1.32	1.40	----	----	-----	-.30	----	----	-----	-.74	2,3
W-180	1.50	5.11	.60	.49	-.11	-18.3	-.58	-.34	.24	41.5	.12	1
W-179	1.50	3.77	.62	.50	-.12	-19.4	-.57	-.30	.27	47.4	.12	1
W-177	1.50	1.98	.75	.71	-.04	-5.3	-.41	-.35	.06	15.0	.24	1
W-176	1.50	1.55	1.21	----	----	-----	-.11	----	----	-----	.68	2
W-175	1.50	1.32	1.61	----	----	-----	-.04	----	----	-----	-.62	2,3
W-186	1.25	5.11	.59	.49	-.10	-16.9	-.57	-.34	.23	40.8	.11	1
W-185	1.25	3.77	.60	.50	-.10	-16.7	-.59	-.30	.29	49.1	.10	1
W-183	1.25	1.98	.79	.73	-.06	-7.6	-.27	-.35	-.08	-29.2	.37	1
W-182	1.25	1.55	1.26	----	----	-----	-.05	----	----	-----	.55	2,4
W-181	1.25	1.32	1.84	----	----	-----	.14	----	----	-----	-.02	2,3
W-195	1.00	5.11	.61	.49	-.12	-19.7	-.57	-.32	.25	43.6	.14	1
W-191	1.00	3.77	.63	----	----	-----	-.57	----	----	-----	.13	2
W-189	1.00	1.98	.71	----	----	-----	-.40	----	----	-----	.18	2,4
W-188	1.00	1.55	1.31	----	----	-----	-.01	----	----	-----	.34	2,3
W-187	1.00	1.32	2.12	----	----	-----	.34	----	----	-----	.40	2,3
W-198	.75	5.11	.62	.49	-.13	-21.0	-.59	-.29	.30	51.2	.14	1
W-196	.75	3.77	.57	----	----	-----	-.56	----	----	-----	.13	2
W-193	.75	1.98	.61	----	----	-----	-.42	----	----	-----	.09	2,4
W-197	.75	1.55	1.02	----	----	-----	-.18	----	----	-----	.09	2
W-192	.75	1.32	1.68	----	----	-----	-.28	----	----	-----	.12	2
W-201	.50	5.11	.60	.49	-.11	-18.3	-.60	-.27	.33	55.1	.12	1
W-199	.50	3.77	.60	----	----	-----	-.58	----	----	-----	.13	2
W-202	.50	1.98	.59	----	----	-----	-.43	----	----	-----	.13	2,3
W-204	.50	1.55	.71	----	----	-----	-.58	----	----	-----	.08	2
W-200	.50	1.32	.91	----	----	-----	-.10	----	----	-----	-.05	2,4
W-210	.25	5.11	.59	.49	-.10	-16.9	-.61	-.25	.36	59.1	.13	1
W-205	.25	3.77	.64	----	----	-----	-.63	----	----	-----	.17	2
W-206	.25	1.98	.54	----	----	-----	-.28	----	----	-----	.15	2
W-209	.25	1.55	.63	----	----	-----	-.58	----	----	-----	.15	2
W-208	.25	1.32	.64	----	----	-----	-.51	----	----	-----	.17	2

[1] Drop inlet dimensions meet the recommended criteria and its performance is satisfactory.

[2] Drop inlet dimensions do not meet the recommended criteria.

[3] Drop inlet performance is poor.

[4] Drop inlet performance is borderline between satisfactory and poor.

TABLE XIII–9.—*Summary of water test results for square drop inlet—flush entrance hood*
$t_p/D = 0.056, S = 0.20$

Series	Z_i/D	B/D	K_e Observed	K_e Computed	K_e Difference	K_e Difference	h_n/h_{vp} at D/2 invert Observed	h_n/h_{vp} at D/2 invert Computed	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 invert Difference	h_n/h_{vp} at D/2 crown	Notes
						Percent				Percent		
W-219	4.00	2.00	.60	.48	-.12	-20.0	-.53	-.31	.22	41.2	.16	1
W-218	4.00	1.50	.71	.61	-.10	-14.1	-.66	-.43	.23	35.3	.40	1
W-215	4.00	1.25	.77	----	----	-----	-.05	----	----	-----	.25	2
W-216	4.00	1.11	.89	----	----	-----	-.07	----	----	-----	.06	3
W-217	4.00	1.00	1.29	----	----	-----	.14	----	----	-----	.09	3
W-223	2.00	2.00	.60	.53	-.07	-11.7	-.51	-.31	.20	39.3	.12	1
W-222	2.00	1.50	.64	.62	-.02	-3.1	-.61	-.43	.18	29.5	.24	1
W-221	2.00	1.25	.77	----	----	-----	-.04	----	----	-----	.09	2
W-220	2.00	1.11	1.01	----	----	-----	-.03	----	----	-----	-.05	3
W-214	2.00	1.00	1.29	----	----	-----	.20	----	----	-----	-.05	3
W-228	1.50	2.00	.61	.55	-.06	-9.8	-.53	-.31	.22	41.1	.12	1
W-226	1.50	1.50	.71	.75	.04	5.6	-.61	-.43	.18	29.5	.25	1
W-225	1.50	1.25	.75	----	----	-----	-.12	----	----	-----	.06	2
W-224	1.50	1.11	.98	----	----	-----	-.01	----	----	-----	-.05	3,4
W-227	1.50	1.00	1.27	----	----	-----	.09	----	----	-----	-.19	3,4
W-233	1.25	2.00	.64	.56	-.08	-12.5	-.54	-.31	.23	42.2	.18	1
W-232	1.25	1.50	.77	.77	.00	.0	-.67	-.43	.24	36.2	.25	1
W-231	1.25	1.25	.87	----	----	-----	-.24	----	----	-----	.04	2
W-230	1.25	1.11	1.05	----	----	-----	-.35	----	----	-----	-.21	3,4
W-229	1.25	1.00	1.35	----	----	-----	-.41	----	----	-----	-.50	3,4
W-238	1.00	2.00	.71	.54	-.17	-23.9	-.58	-.28	.30	52.1	.20	1
W-234	1.00	1.50	.82	.71	-.11	-13.4	-.72	-.38	.34	47.4	.36	1
W-235	1.00	1.25	.94	----	----	-----	-.29	----	----	-----	.07	3,5
W-236	1.00	1.11	1.14	----	----	-----	-.52	----	----	-----	-.21	3,4
W-237	1.00	1.00	1.27	----	----	-----	-.59	----	----	-----	-.32	3,4
W-241	.75	2.00	.69	.53	-.16	-23.2	-.55	-.25	.30	54.8	.13	1
W-240	.75	1.50	.74	.65	-.09	-12.2	-.62	-.33	.29	46.4	.46	1
W-239	.75	1.25	.89	----	----	-----	-.18	----	----	-----	.23	3
W-243	.75	1.11	1.02	----	----	-----	-.22	----	----	-----	.35	3,6
W-242	.75	1.00	1.08	----	----	-----	-.28	----	----	-----	.39	3,6
W-247	.50	2.00	.64	.51	-.13	-20.3	-.37	-.23	.14	38.3	.18	1
W-246	.50	1.50	.68	.59	-.09	-13.2	-.47	-.27	.20	42.7	.45	1
W-245	.50	1.25	.74	----	----	-----	-.36	----	----	-----	.30	3
W-248	.50	1.11	.74	----	----	-----	-.48	----	----	-----	.12	3,6
W-244	.50	1.00	.77	----	----	-----	-.39	----	----	-----	.18	3,6
W-250	.25	2.00	.61	.50	-.11	-18.0	-.41	-.20	.21	51.7	.16	1
W-251	.25	1.50	.62	.53	-.09	-14.5	-.36	-.22	.14	39.6	.45	1
W-252	.25	1.25	.64	----	----	-----	-.35	----	----	-----	.22	3
W-253	.25	1.11	.65	----	----	-----	-.34	----	----	-----	.15	3,5
W-249	.25	1.00	.63	----	----	-----	-.45	----	----	-----	.13	3

[1] Drop inlet dimensions meet the recommended criteria and its performance is satisfactory.
[2] Drop inlet dimensions meet the recommended criteria but the equations are not valid.
[3] Drop inlet dimensions do not meet the recommended criteria.
[4] Drop inlet performance is poor.
[5] Drop inlet performance is borderline between satisfactory and poor.
[6] Drop inlet performance is satisfactory but the headpool surface level fluctuates slightly.

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PEORIA, ILLINOIS 61614